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# POWER AFRICA GAS ROADMAP TO 2030

## ACKNOWLEDGEMENT

Many individuals and organizations contributed to the development of this *Power Africa Gas Roadmap*. This strategy blends the ideas, input, and vision from a wide range of Power Africa's many partners, including those serving in U.S. Government agencies and posts across sub-Saharan Africa, the private sector, international finance institutions, and other partners.

In particular, we would like to extend a special thanks to the following people outside of the U.S. Government, who provided detailed input and insight: **Adrian P. Hamra**—ExxonMobil; **Robert Appelbaum, John Smelcer, Gibbs Johnson**—Webber Wentzel; **Angelo Madera, Alessandro Gelmetti, Nadira Haraigue**—Eni; **Kribs Govender**—Sasol; **Marcel Bruhwiler**—International Finance Corporation; **Jeffrey Krilla**—Kosmos Energy; **Frederik Smits van Oyen**—Cheniere; **Katan Hirachand**—Société Générale; **Paul Eardley-Taylor**—Standard Bank; **Ross Boyd**—General Electric.

Finally, a special acknowledgement to all of the staff across U.S. Government agencies and departments involved in developing this *Power Africa Gas Roadmap*.

Cover: The 180 MW Songas Ubungu generation plant in Dar es Salaam, Tanzania, supplies nearly one-quarter of the country's electricity and uses the country's own natural gas resources (Photo: Songas/Globeleq)

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## FOREWORD BY RICK PERRY UNITED STATES SECRETARY OF ENERGY



On my childhood farm in rural Texas, my family had a small windmill that would, on windy days, provide power for a few short hours. There was no predicting when the lights might be on, or when critical machinery might work. For years, our farm's production efficiency, not to mention quality of life, was at the whim of the wind.

Today, a similar lack of reliable electricity impacts millions of people across Africa. I know firsthand from my engagements on the continent that the energy challenges of African nations are real. However, I also know that the solutions are real, and that the United States is committed to partnering with our allies in Africa to power businesses and schools, homes and clinics, and family farms much like the one where I was raised.

A key ingredient in Africa's energy mix is, and will continue to be, clean natural gas. Natural gas and liquefied natural gas (LNG) projects have the potential to generate essential electricity quickly, and at reasonable prices. Gas-fired power plants also work well alongside other generation technologies, and their replacement of fuels like diesel and kerosene contributes to a healthier environment.

This *Power Africa Gas Roadmap* underscores how the United States can help advance gas sector investment in several countries, as well as how the export of LNG and related innovation from the United States can spur gas-to-power development across the continent. It is also a perfect companion to the *Understanding Natural Gas and LNG Options* handbook developed by the U.S. Department of Energy and the U.S. Energy Association, with support from Power Africa.

The United States' position as a leader in the global gas market creates an ideal synergy for American and African companies to work together on gas export and import projects. Already, many gas-to-power projects in Africa utilize parts and technology designed and built in the United States, and nearly all large-scale LNG facilities in operation use liquefaction processes licensed and developed in the United States.

The *Power Africa Gas Roadmap* also exemplifies the United States' drive towards energy security and shared prosperity for our partners and allies. This *Roadmap* is a critical tool for the United States to achieve its National Security Strategy goal of attaining "universal energy access to lift people out of energy poverty and foster economic development" and involves using our abundant energy resources to support self-reliance, competitive markets, and stability around the world. America, as an energy-dominant nation and global leader, will continue to export resources, knowledge, and tools to boost energy markets across the globe.

Through Power Africa and other initiatives, the United States is investing in infrastructure, technology, and services that will change lives and charge economies. Together, we are helping our partners in Africa generate new power through mutually beneficial and sustainable energy development.

I am confident that the guidance and direction charted in this *Power Africa Gas Roadmap* will accelerate the advancement of our shared goals.

*Rick Perry*

## PREFACE BY **MARK GREEN** USAID ADMINISTRATOR



When I ended my service as U.S. Ambassador to Tanzania in 2009, the population of Africa had just passed one billion people. By the year 2050, it will be double that.

No amount of government intervention alone can possibly create the jobs necessary to employ so many people. Only entrepreneurialism and private-sector growth have the potential to lift people out of poverty on that scale. This Roadmap illustrates how gas not only can power current industries today, but also generate entirely new ones tomorrow — which will provide millions of jobs.

By focusing on Africa's vast natural gas reserves, riding the momentum of growth in market demand and leveraging private sector investment, USAID and Power Africa expect to make substantial progress in promoting Africa's resilience and self-reliance in the coming years. This will improve regional stability, as African economies continue to grow and expand, and create opportunities for young people.

The *Power Africa Gas Roadmap* will support America's economic prosperity by expanding the number of American firms that work in Africa with expertise in this abundant fuel. Power Africa is committed to strengthening U.S. engagement and leadership in Africa as we work to foster free and open markets, and promote sustainable and transparent enabling environments for business.

Power Africa and natural gas are a classic win-win, and I look forward to being a part of it.

A handwritten signature in black ink, appearing to read 'Mark Green'.



The Songas integrated gas-to-electricity facility in Tanzania includes a gas processing plant, transportation pipeline and power plant. Photo: Globeleq

## EXECUTIVE SUMMARY

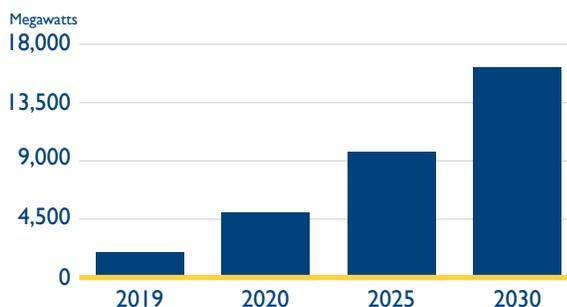
In the *Power Africa Roadmap*, published in 2016, we illustrated how the collective effort of Power Africa's public and private sector partners were working together to achieve an ambitious goal of adding **30,000 megawatts (MW)** of new electricity generation capacity and **60 million** new connections by 2030.

Since we released the Roadmap, Power Africa has expanded to more than **160** partners, including new government and donor partners, and even more of the world's top energy and technology companies.

This *Power Africa Gas Roadmap* builds on the *Power Africa Roadmap* to outline a plan for achieving up to **16,000 MW** of additional gas-fired power generation in sub-Saharan Africa by 2030, which is over 50 percent of Power Africa's topline goal. **Exhibit I** illustrates the anticipated impact of Power Africa support for gas-to-power projects.

### EXHIBIT I

#### ANTICIPATED, CUMULATIVE IMPACT OF GAS INTERVENTIONS BY 2030



Power Africa sees **five key reasons to focus on gas**:

- 1. RESOURCE POTENTIAL:** Based on known reserves, there is potential for approximately 400 gigawatts (GW) of gas-generated power in sub-Saharan Africa.
- 2. ECONOMICS:** With the drop in global prices, the use of gas has become more attractive, and could replace more expensive fuel sources, thus reducing the cost of energy. With lower prices, businesses can thrive and more people can have access to electricity. In addition, carbon emissions from natural gas usage is much lower than emissions from coal and oil-based fuels like kerosene, diesel, gasoline, and heating oil, as well as burning biomass for cooking.
- 3. MOMENTUM:** Many African countries are actively pursuing programs to grow their gas economies. Not just gas-to-power, but also industrial and transport gas markets.
- 4. CATALYZATION IMPACT:** Decreasing the risk of new projects by improving returns for upstream gas production and proving viability can create stronger markets for gas.
- 5. DIVERSIFICATION AND FLEXIBILITY:** Gas-fired plants complement the generation profiles of renewable sources, thereby increasing the reliability and availability of power.

The *Power Africa Gas Roadmap* provides a comprehensive framework for defining and coordinating gas-to-power activities supported by Power Africa and partners through 2030. This Roadmap is designed to optimize and leverage Power Africa's key strengths to achieve a discrete and measurable set of objectives. Although constraints and bottlenecks to the development of gas-fired power generation still exist, new gas discoveries—in combination with advances in technology and increasing activity from domestic and international investors—have produced the conditions for an “African Gas Revolution.”<sup>1</sup> Power Africa is uniquely positioned to achieve this revolution and drive real outcomes in sub-Saharan Africa's gas-to-power markets.

## THE GOAL

In the *Power Africa Roadmap*, we demonstrated how Power Africa's innovative, private sector-led model is clearing hurdles and accelerating transactions of all types. The objective of this *Gas Roadmap* is to outline how Power Africa and its partners can advance the current portfolio of gas projects toward financial close. The ambitious target of up to 16,000 MW is based on the projects that could likely reach financial close by 2030, taking into consideration:

- the existing constraints in each of these countries; and
- what Power Africa could potentially do in this period to assist in alleviating these constraints.

## GAS POTENTIAL IN AFRICA

Gas resources have been identified in 14 countries in sub-Saharan Africa, with Nigeria accounting for 81 percent of proven reserves. Several undeveloped fields in Mozambique and Tanzania account for 62 percent of total contingent resources.<sup>2</sup> Other African countries without their own reserves will need to develop infrastructure for importation of natural gas to support local demand (power generation and other), which will require sufficient investment in upstream natural gas infrastructure. Already, several governments in sub-Saharan Africa are

actively pursuing programs to grow their gas economies through the development of industrial and transport gas markets, in conjunction with gas-to-power programs.

If planned facilities are completed, **gas could become the dominant fuel for generating power in Africa.**<sup>3</sup>

## FOCUSING SUPPORT

While Power Africa supports gas-to-power projects across sub-Saharan Africa, this *Gas Roadmap* focuses on nine, strategically selected countries, highlighted in blue in **Exhibit 2:**

- Côte d'Ivoire
- Senegal
- South Africa
- Ghana
- Angola
- Kenya
- Nigeria
- Mozambique
- Tanzania

**EXHIBIT 2**  
GAS ROADMAP FOCUS COUNTRIES



1 Castellano, A., Kendall, A., Nikomarov, M and Swemmer, T. (2015) *Brighter Africa: The growth potential of the sub-Saharan electricity sector*. [online] Available at: [http://www.mckinsey.com/~media/McKinsey/dotcom/client\\_service/EPNG/PDFs/Brighter\\_Africa-The\\_growth\\_potential\\_of\\_the\\_sub-Saharan\\_electricity\\_sector.ashx](http://www.mckinsey.com/~media/McKinsey/dotcom/client_service/EPNG/PDFs/Brighter_Africa-The_growth_potential_of_the_sub-Saharan_electricity_sector.ashx).

2 *Harnessing African Natural Gas: a new opportunity for Africa's energy agenda?* World Bank, 2014. <http://documents.worldbank.org/curated/en/858091468203694236/Harnessing-African-natural-gas-a-new-opportunity-for-Africas-energy-agenda>

3 *BP Energy Outlook 2017* (<https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf>)

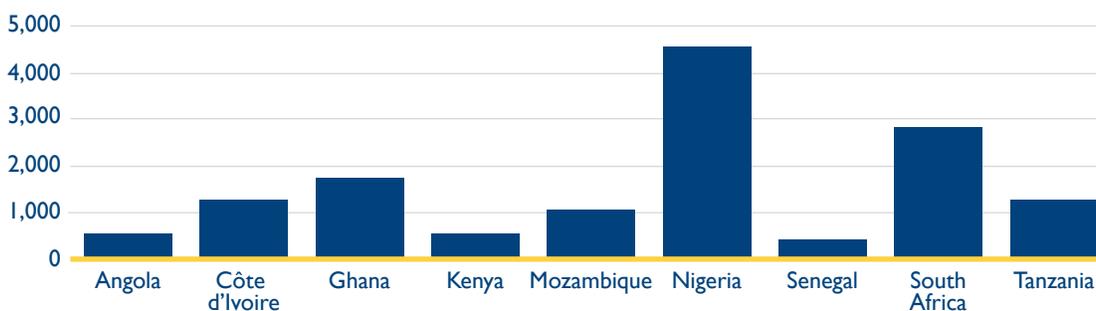
We estimate that **these countries hold the potential for around 16,000 MW (86 percent) of new gas-fired power generation projects through 2030.**

These focus countries were selected due to their relatively large populations, high gross domestic product (GDP), and either because they have local gas resources (in operation or under development) or are planning liquified natural gas (LNG) import projects. **Exhibit 3** highlights the projected generation capacity in these focus countries through 2030.

Due to gas-related regional dynamics, this *Gas Roadmap* groups focus countries into two regions: 1) West Africa, and 2) East and Southern Africa. The East and Southern Africa countries are categorized together as they present significant gas markets and gas supply options to each other for intra-basin or regional trade. For more details on analysis around Southern Africa's regional trade potential, please refer to Power Africa's *Southern Africa Gas Roadmap*.

### EXHIBIT 3

#### PROJECTED GAS-FIRED GENERATION CAPACITY IN FOCUS COUNTRIES THROUGH 2030



## INTERVENTIONS

To ensure that future Power Africa interventions in the gas sector are focused where they will deliver the maximum impact, this *Gas Roadmap* analyzes the gas-to-power value chain, typical transaction structures, make-up of the tariffs, major constraints encountered by the market, and where Power Africa partner interventions are in place.<sup>4</sup>

By focusing on decreasing fuel costs, development costs, and the cost of capital, the best possible tariffs for the end user can be realized. Power Africa's interventions will focus on addressing the constraints related to gas projects in sub-Saharan Africa, including:

- The availability of gas (both from a source as well as delivery method perspective);
- Financial strength of off-takers of power and gas;
- Lag in downstream infrastructure, such as power transmission and distribution capacity; and
- The various markets' ability to absorb power and gas.

Power Africa's interventions will focus on addressing the constraints related to gas projects in sub-Saharan Africa.

<sup>4</sup> For more on gas-to-power transaction structures, see *Understanding Natural Gas and LNG Options*, the third volume in a series of handbooks Power Africa co-produced, following *Understanding Power Purchase Agreements* and *Understanding Power Project Financing*. <https://energy.gov/ia/articles/understanding-natural-gas-and-lng-options>

The **Top 8 strategic interventions** (in no specific order):

- 1. Develop an Integrated Gas Economy Planning Tool for each country and region.** The focus of the tool will be on quantifying current and future market and supply options.
- 2. Develop and/or update Gas Master Plans** to ensure streamlining, relevancy and correct implementation.
- 3. Update regulations and policies** to fit the current requirements to support the increase of gas in the energy mix.
- 4. Strengthen the financial capacity** and creditworthiness of state entities.
- 5. Assist in increasing power transmission and distribution capacity and reliability.**
- 6. Create a simplified and streamlined protocol for more efficient decision making** within and among each of the various state entities and regulators to provide certainty regarding approval and permitting procedures for potential investors in the sector.
- 7. Review proposed LNG import projects** to determine, among other things, procurement process, optimal location, commercial structure, and requirements for LNG volumes over time.
- 8. Assist development of CNG and small-scale LNG projects** to monetize local gas resources, as well as serve local demand centers.

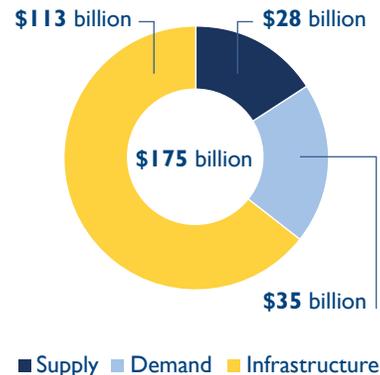
Detailed interventions for each focus country are outlined in pages 21–51.

## OPPORTUNITIES FOR U.S. COMPANIES<sup>5</sup>

This *Gas Roadmap* highlights how **the gas value chain in sub-Saharan Africa has high potential**, offering rich investment and export opportunities for U.S. companies, including the ability to on-shore additional manufacturing jobs in the United States. U.S. companies have a long history and deep experience in the global gas sector, and are, therefore, well positioned for engagement. The total

estimated cost for power project development that U.S. companies could invest in or compete for is **\$175 billion**, as outlined in **Exhibit 4**.

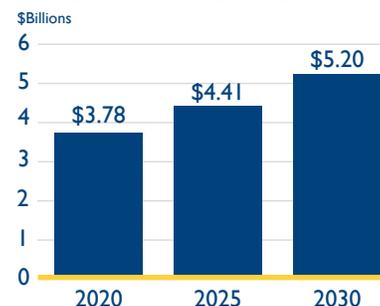
**EXHIBIT 4**  
ESTIMATED CAPITAL COSTS  
FOR 16,000 MW SCENARIO



A **Gas Opportunity Matrix**, describing all opportunities for each focus country, is provided on page 57.

It should also be noted that the relative proximity of various sub-Saharan markets to the United States presents an opportunity for U.S. LNG companies seeking to market new liquefaction capacity to underpin multi-billion-dollar investments in new export projects. With the cost of shipping U.S. LNG to sub-Saharan Africa being 20-40 percent lower than shipping LNG to North Asia, U.S. LNG projects are in a position to compete in the sub-Saharan Africa market. If 10 percent of the projected demand for gas in Africa is supplied by imported LNG, the annual market value for export is significant, as highlighted in Exhibit 5:<sup>6</sup>

**EXHIBIT 5**  
LNG EXPORT POTENTIAL



<sup>5</sup> In November 2017, USTDA launched the U.S. Gas Infrastructure Exports Initiative to connect American companies to export opportunities across the gas value chain in emerging economies. <https://www.ustda.gov/program/us-gas-infrastructure-exports-initiative>

<sup>6</sup> Based on projections as per BP Energy Outlook 2017 (<https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf>) and a LNG selling price of \$7.00/MMBtu



Inspecting equipment at the 430 MW Azito facility near Abidjan, Côte d'Ivoire

## INTRODUCTION

### POWER AFRICA'S FOCUS ON GAS

Power Africa sees **five key reasons to focus on gas**:

1. **RESOURCE POTENTIAL:** Based on known reserves, there is potential for approximately 400 gigawatts (GW) of gas-generated power in sub-Saharan Africa.
2. **ECONOMICS:** With the drop in global prices, the use of gas has become more attractive, and could replace more expensive fuel sources, thus reducing the cost of energy. With lower prices, African power sectors can become more solvent, businesses can thrive, and more people can have access to electricity. In addition, carbon emissions from natural gas usage is much lower than emissions from coal and oil-based fuels like kerosene, diesel, gasoline, and heating oil, as well as burning biomass for cooking.
3. **MOMENTUM:** Many African countries are actively pursuing programs to grow their gas economies. Not just gas-to-power, but also industrial and transport gas markets.

4. **CATALYZATION IMPACT:** Decreasing the risk of new projects by improving returns for upstream gas production and proving viability can create stronger markets for gas.
5. **DIVERSIFICATION AND FLEXIBILITY:** Gas-fired plants complement the generation profiles of renewable sources, thereby increasing the reliability and availability of power.

### RESOURCE POTENTIAL

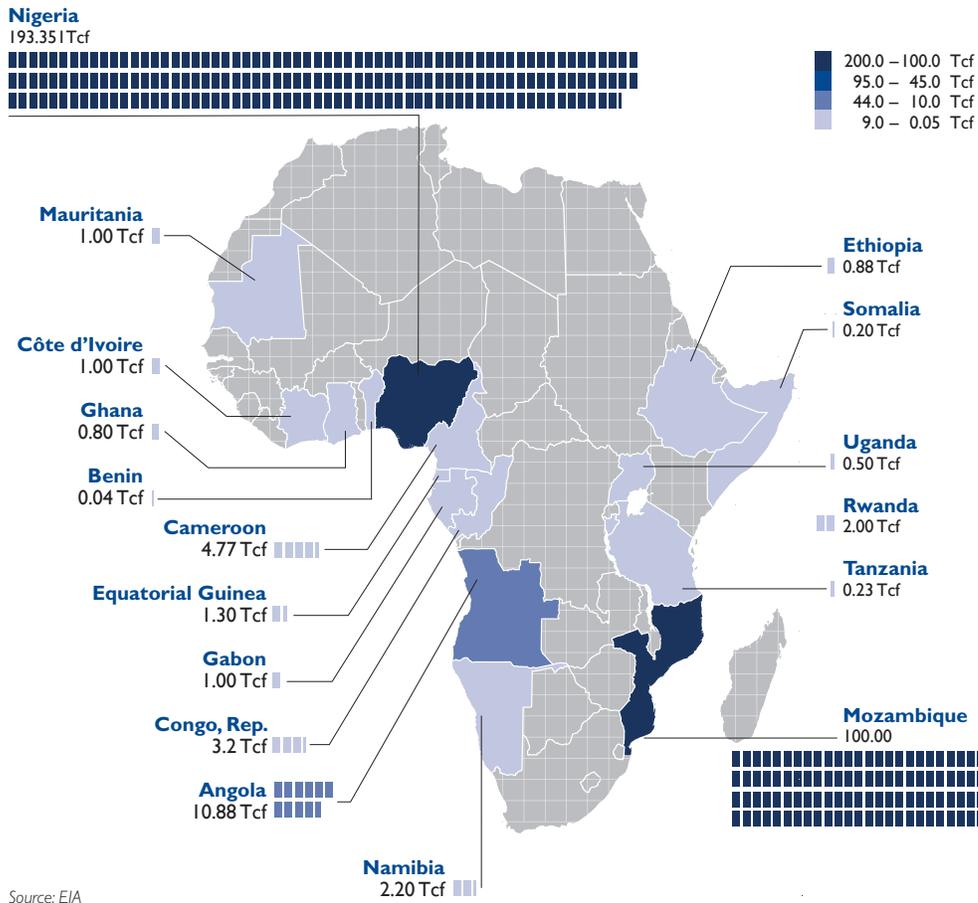
Although gas resources have been discovered in 14 countries, Nigeria accounts for 81 percent of proven reserves; the three LNG-exporting countries—Nigeria, Angola, and Equatorial Guinea—account for 92 percent. The huge undeveloped fields in Mozambique and Tanzania account for 62 percent of total contingent resources.<sup>7</sup>

**Exhibit 6** highlights the proven gas reserves in sub-Saharan Africa. **Exhibit 7** illustrates the amount of current, installed gas-fired generation capacity relative to overall installed capacity.

<sup>7</sup> *Harnessing African Natural Gas: a new opportunity for Africa's energy agenda?* World Bank, 2014. <http://documents.worldbank.org/curated/en/858091468203694236/Harnessing-African-natural-gas-a-new-opportunity-for-Africas-energy-agenda>

**EXHIBIT 6**

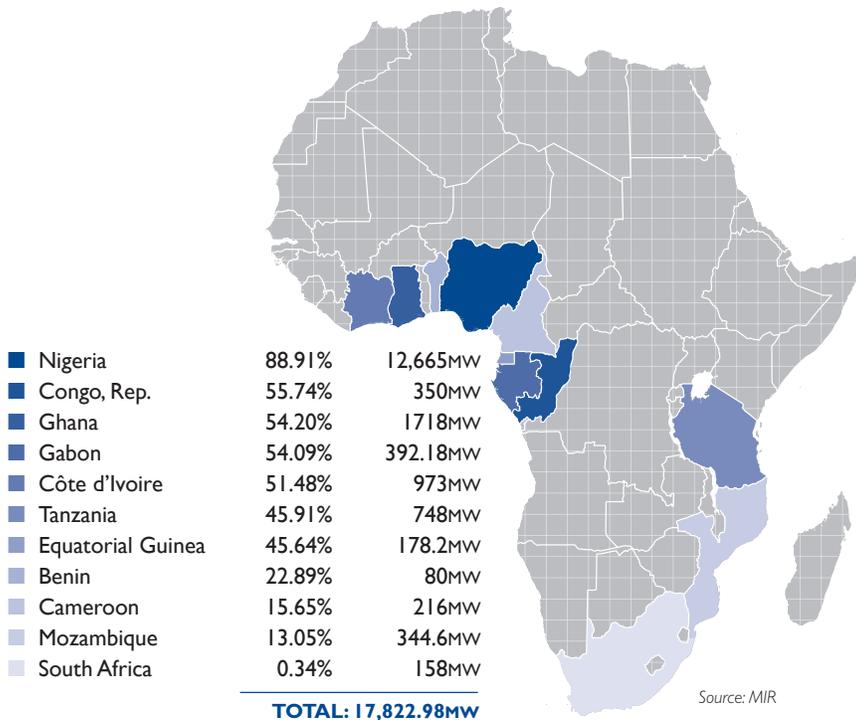
**PROVEN GAS RESERVES IN SUB-SAHARAN AFRICA**



**EXHIBIT 7**

**CURRENT, INSTALLED GAS-FIRED GENERATION CAPACITY**

(TOTAL MW AND PERCENTAGE OF OVERALL GENERATION CAPACITY)



## ECONOMICS

Gas is highly competitive as a new source of power. A 2016 study found that prices for gas-to-power could run as low as \$0.10/kWh for integrated LNG projects and \$0.15/kWh for small-scale and distributed power projects.<sup>8</sup> Both projected prices are lower than the \$0.18/kWh average cost of generation in sub-Saharan Africa. Recent gas-to-power transactions in Ghana, Nigeria, and Mozambique utilizing local gas resources have yielded tariffs

of \$0.07 - \$0.09/kWh. **Exhibit 8** outlines the comparative prices of power generation in sub-Saharan Africa.

**Exhibit 9** on the next page shows the average cost of various fuel sources typically used in thermal power generation, as well as transport and industrial sectors in sub-Saharan Africa that could be substituted with natural gas.

### EXHIBIT 8

#### COMPARATIVE PRICES OF INDEPENDENT POWER PROJECTS IN SUB-SAHARAN AFRICA



**Large hydropower** independent power projects (IPPs) have emerged, albeit only in the form of Bujagali in Uganda (250 MW) and, more recently, Itezhi in Zambia (120 MW). Bujagali, at **\$0.10/kilowatt-hour (kWh)**, has helped offset higher-priced thermal installations (**\$0.24–0.27/kWh**) in the country.



**Small hydropower** IPPs (<20 MW) have seen an upsurge in activity, particularly in Uganda. Each of the small hydropower IPPs (**at around \$0.099/kWh**) are superior, pricewise, to the thermal alternatives (heavy fuel oil, HFO), which rely on imported fuel.



On the **geothermal** front, private investments in Kenya date to 1999, when OrPower won the first tender. At **\$0.09/kWh**, the IPP geothermal plant is slightly more expensive than state-run geothermal plants (**\$0.07/kWh**).



**Biomass** IPPs are well established in Mauritius, South Africa, Kenya, Uganda, and, most recently, Angola, have also added biomass to their electric power supply. Kenya's Mumias IPP plant, at **\$0.05/kWh**, is more competitive than geothermal and is outcompeting any fuel-to-power alternative, as noted. Uganda's new biomass plants have a tariff of **\$0.10/kWh**.



When looking at independent **diesel or HFO** power plants, which are prevalent across the continent, prices in Kenya can range from **\$0.14/kWh** to as high as **\$0.25/kWh**. One of Tanzania's earliest IPPs—IPTL—has costs as high as **\$0.31/kWh**. Emergency power plants in Tanzania, relying on HFO, diesel and/or jet fuel, are estimated to cost up to **\$0.40/kWh**. Actual prices depend on the mode of procurement and the degree of competition. IPTL in Tanzania, which was not competitively procured, is amongst the most expensive diesel IPPs in the region, while the latest Kenya diesel procurements were much more competitive and achieved much lower prices.



For **gas-to-power** IPPs, prices differ across the continent, as each project is highly dependent on the input gas price, which is often subsidized, giving an unrealistic picture of the price of these projects. However, the 200 MW Songas IPP in Tanzania provides a useful case, as the price of gas is unsubsidized. Its total cost, evaluated at **\$0.05/kWh**, is competitive compared to other thermal plants in Tanzania and elsewhere, notably diesel or HFO power plants.

*Source: Eberhard, A, Gratwick, K, Morella, E, Antmann, P (2016). "Independent Power Projects in sub-Saharan Africa: Lessons from Five Key Countries." World Bank, Washington D.C.*

8 Eberhard, A, Gratwick, K, Morella, E, Antmann, P (2016). "Independent Power Projects in sub-Saharan Africa: Lessons from Five Key Countries."

## EXHIBIT 9

### AVERAGE COST OF VARIOUS MODERN FUEL SOURCES IN SUB-SAHARAN AFRICA

FUEL SOURCE	AVERAGE \$/GJ IN SSA
HFO	23-27
Diesel	35-38
LPG	39-42
Petrol	38-41
Coal (20 MJ/kg mouth of mine)	2-4
Coal (24 MJ imported)	5-9

Source: SGS

These figures illustrate the **clear opportunity to displace some liquid fuel consumption with natural gas**. The constraint, however, is the availability of gas, which can be overcome with scale and more flexible supply, distribution, and import infrastructure options. There are numerous sources of gas scattered across the continent that are either too small for large-scale power use, or are awaiting certainty of large-scale, long-term offtake to bank upstream development costs. Many of these have existing exploration wells that have been venting gas for a number of years. A typical exploration well can produce between 50,000-150,000 gigajoules (GJ) (or 14 - 47 MMscf) of gas per annum, which is too small for large-scale power generation that, as a rule of thumb, requires 100,000 GJ (94 MMscf) per MW per year. It is, however, interesting for an existing liquid fuel user in the transport or industrial sector and owners.

The environmental benefits of natural gas usage compared to other fossil fuels and biomass could also translate into economic benefits as a result of lower cost of capital, decreased financial liabilities with regards to environmental management, and potential income from carbon trading mechanisms.

## MOMENTUM

Several governments in sub-Saharan Africa are actively pursuing programs to grow their gas economies through the development of industrial and transport gas markets, in conjunction with gas-to-power programs. Gas bunkering for fueling oceangoing vessels is also a growing opportunity that should be explored by African governments and companies.

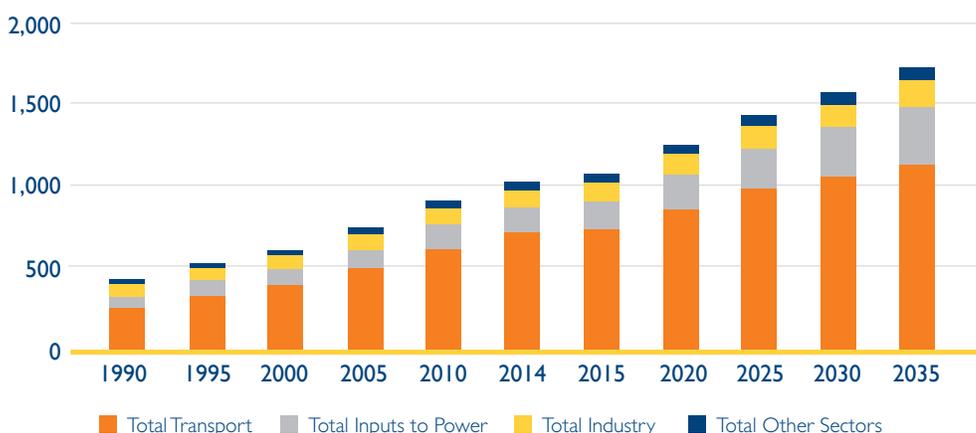
The benefits of this approach include:

- Early monetization of gas resources, improving returns for upstream companies, and accelerating the further development of the resource;
- The creation of a market for the gas that grows exponentially over time; and
- Proof of the technical and commercial viability of the gas supply.

Exhibit 10 shows that there is volume growth in the power market, but that the combined transport and industrial

## EXHIBIT 10

### ENERGY CONSUMPTION BY SECTOR IN AFRICA (MILLION TONNES OF OIL EQUIVALENT)



Source: BP Energy Outlook 2017

markets are significantly larger consumers of energy. There are various ways to link gas sources to gas markets depending on volume and the distance between source, as shown in **Exhibit 11**.

Compressed natural gas (CNG) is a proven method of transporting smaller volumes of gas over shorter distances. Advances in mini-LNG, trucking, and rail transportation makes LNG an avenue to investigate, as well.

## CATALYZATION IMPACT

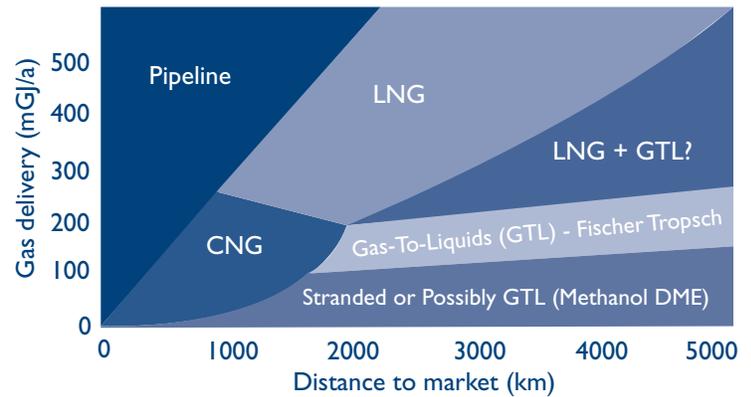
History shows that **the introduction and/or increased supply of gas as an alternative energy source has a transformative impact on economies.** The construction schedule of a combined cycle gas turbine (CCGT) plant is approximately 30-36 months (with open cycle capability often being available after roughly 20 months). The feasibility, licensing, and financial close process of these projects can take anywhere between 2-5 years. In the interim, there are many other users that would be able to utilize the gas if it was available. The markets for liquid fuel products in Africa make up roughly 40 percent of the total energy consumption and are projected to hold steady for the near future (this number is even greater when only sub-Saharan Africa is taken into consideration).

## DIVERSIFICATION AND FLEXIBILITY

Gas-fired plants complement the generation profiles of renewable sources, thereby increasing the potential to add more renewable generation to a system. In terms of flexibility, the relatively short construction time required to build a gas-fired power generation facility can be an important incentive for governments across sub-Saharan Africa. **With average development times of approximately two to three years, gas-fired power plants can fill critical electricity gaps much more quickly than large-scale hydro, coal-fired or nuclear plants,** which can take up to seven years to construct.<sup>9</sup>

9 IEA. 2015. Projected costs of generating electricity. Paris: IEA/NEA.

**EXHIBIT 11**  
GAS TRANSPORT OPTIONS

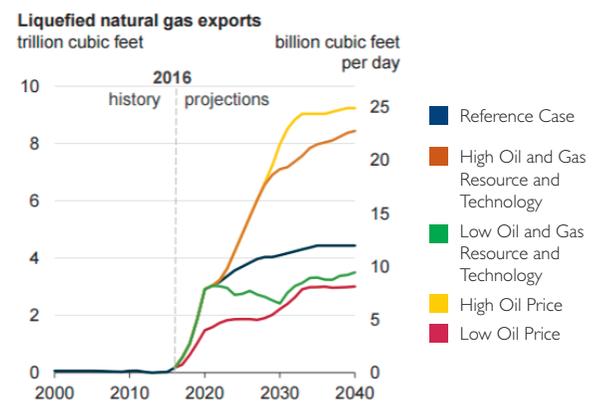


Source: Gas Monetization Options, Shell

## THE GLOBAL LNG MARKET: WHY IMPORTED LNG NOW MAKES SENSE FOR AFRICA

In the last decade, the world witnessed the United States' transition from being a liquefied natural gas (LNG) importer to a growing LNG exporter (see **Exhibit 12**). This shift changed the dynamics of the global gas market such that it has gone from being a "seller's market" to a "buyer's market." Now, even for many African countries that do not have indigenous gas reserves, gas-to-power projects can still become a reality by importing LNG and developing the associated LNG-to-power infrastructure, such as offshore floating storage and regasification units (FSRUs) or onshore LNG terminals and related infrastructure.

**EXHIBIT 12**  
GLOBAL LNG EXPORTS



Source: U.S. Energy Information Administration, "Annual Energy Outlook 2017"

South Africa could import 100 million gigajoules (GJ) (95 Bcf) of LNG annually to fuel 3,000 MW of gas-to-power generation by 2030. Given the changes in the global LNG market, a country like South Africa should be able to import LNG on more competitive and flexible terms since producers will need to place shipments of LNG that may not have been sold forward on long-term contracts, meaning prices may be discounted; and demand growth may shift to smaller, niche markets, such as those in many African countries.

**Exhibit 13** breaks down whether proposed gas-fired generation projects in the nine focus countries would be supplied by indigenous gas or LNG imports. This distinction is important as it determines the interventions required for supply options, as well as the infrastructure required to deliver gas to the point of use.

**EXHIBIT 13**

PROPOSED GAS-FIRED GENERATION PROJECTS IN FOCUS COUNTRIES

	ESTIMATES OF CURRENT AND POTENTIAL GAS PROJECTS UNDER ASSESSMENT	PERCENTAGE OF PROPOSED GENERATION INCREASE BY GAS SUPPLY SOURCE	
	PROPOSED MW OF GAS-FIRED GENERATION	INDIGENOUS PRODUCTION	LNG IMPORTS
<b>West Africa</b>			
Côte d'Ivoire	1,100	75%	25%
Ghana	3,000	50%	50%
Nigeria	8,000	100%	Some possible
Senegal	TBD portion of HFO Capacity	100%	Some possible
<b>East Africa &amp; Southern Africa</b>			
Angola	2,000	100%	-
Kenya	750	Unclear at present	Unclear at present
Tanzania	3,000	100%	-
Mozambique	1,100	100%	Some possible
South Africa	5,200	10%	90%

Source: Gas Strategies, LLC. report for Power Africa, based on the Power Africa Tracking Tool, national gas policy and planning documents, and Gas Strategies' database of LNG import projects under development in sub-Saharan Africa. This table includes data from all projects in our focus countries, not just the projects being tracked by Power Africa.

**For the United States and U.S.-based companies, the benefits of increased African demand are three-fold:**

1. Africa can become an additional market for gas from the United States;
2. Africa can be a customer for U.S. Companies that design and build LNG facilities and other gas infrastructure; and/or
3. Increased demand from Africa could support prices and revenue for U.S. producers by preventing oversupply in the market.

## ADVANCING U.S. POLICY GOALS

The *Power Africa Gas Roadmap* aligns with the Department of State and USAID Joint Strategic Plan (JSP) and the United States National Security Strategy.<sup>10</sup> These strategies and plans include emphasis on diversification of energy sources, suppliers and routes; removing barriers to energy trade and promoting U.S. exports; working to attain universal energy access; and ensuring energy security for U.S. allies and partners. In particular, this Roadmap aligns with:

- The National Security Strategy objective to Embrace Energy Dominance through reducing barriers, promoting exports, ensuring energy security, attaining universal energy access and furthering America's technological edge; and
- Strategic Objective 2.3 of the JSP: Advance U.S. economic security by ensuring energy security, combating corruption, and promoting market-oriented economic and governance reforms.

The *Power Africa Gas Roadmap* focuses primarily on the role of gas as it relates to power generation. However, many U.S. Government agencies lead other comprehensive gas-related programs and initiatives.



Secretary of Energy Rick Perry is joined by U.S. Secretary of Interior Ryan Zinke, Administrator, Environmental Protection Agency, Scott Pruitt and Director of National Economic Council Gary Cohn for a roundtable discussion on Energy Dominance: Policy Framework for the Future on June 29, 2017. Photo: Simon Edelman, U.S. Department of Energy

<sup>10</sup> The 2018 *National Security Strategy of the United States of America* is available at <https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf>, and the FY 2018-2022 Department of State and USAID Joint Strategic Plan is available at <https://www.state.gov/s/d/rm/rls/dosstrat/2018/pdf/index.htm>

# REACHING OUR GOALS THROUGH GAS

## POWER AFRICA'S GAS STRATEGY

This strategy builds on Power Africa's successes assisting 19 gas projects reach financial close in 6 countries, totaling **4,152 MW**. The pipeline of projects Power Africa is tracking includes 60 gas projects in 17 countries, with a potential new generation capacity of more than **17,000 MW**.

This section provides a high-level summary of the specific market dynamics and risks that could impact the achievement of the Roadmap's primary MW goals. While this assessment is current as of June 2018, the risk and market profile of the regions and focus countries should be assessed regularly and workplans updated on a regular basis to ensure that Power Africa's activities meet the goals of this *Gas Roadmap*.

Each of the nine countries addressed in this *Gas Roadmap* has different requirements, and the approach to stimulating each gas market should therefore be tailored accordingly. This section provides some context for each of the markets and a tailored set of interventions that Power Africa can deliver to support the growth of the gas sector:

### Primary Activities

A critical success factor to achieving the **16,000 MW** target is selecting projects and project interventions in which we can have the greatest impact and maximize our relative competitive strength in advancing projects. The 16,000 MW is built from a set of selected projects categorized into three intervention areas:

1. 8,000 MW through maximizing value from existing transactions;
2. 7,000 MW through advancing new opportunities for deal flow; and
3. 1,000 MW through increasing the efficiency of existing generation facilities.

For each project, Power Africa and partners relevant to the transaction propose to tailor project support based on: (a) analysis of the deal, (b) engagement with the "buy-side" client, and (c) engagement with the "sell-side" client to ensure that we are providing the right solution, or

OUR OVERALL GOAL  
to enable electricity access by adding

 **30,000 MEGAWATTS**  
of new and cleaner power generation

 **60 MILLION**  
new electricity connections

set of solutions, at the appropriate stage of the project's development. Projects will be reviewed on a regular basis to ensure effective service delivery and to adjust/change support depending the transactions' life cycle and specific obstacles that have emerged.

Power Africa recognizes that the project portfolio will not be static. Projects can be added or removed. The key idea is maintaining a commitment to a long-term strategy of advancing a focused project portfolio.

A critical success factor will be selecting projects and interventions that can have the greatest impact and maximize Power Africa's competitive strengths.

### Secondary Activities

Power Africa recognizes that **broader enabling environment and market reforms are critical to the development of sub-Saharan African gas-to-power markets**. While some power generation projects have managed to achieve financial close in less than optimal policy or market conditions, we recognize that improving the enabling environment is key to unlocking the full potential of sub-Saharan gas-to-power markets. Power Africa has had some success in facilitating policy and institutional reforms. For this *Gas Roadmap*, Power Africa will focus policy reform support on activities (in those countries with prioritized projects) that will have the most impact on advancing gas-to-power transactions:

- Developing, finalizing, and implementing policies and regulations to enable upstream developers to monetize the gas required to kick-start domestic gas demand in countries such as Angola, Tanzania, and Mozambique.

- Creating a simplified and streamlined protocol for more efficient decision making among each of the various state entities and regulators. Simplified decision making can help provide certainty regarding approval and permitting procedures for potential investors in countries such as Ghana and Côte d'Ivoire.
- Updating Gas Master Plans to ensure streamlining, relevancy, and correct implementation in countries such as Mozambique, Senegal, and Nigeria.
- Measure a basket of associated energy and economic indicators relevant to each country;
- Enable scenario planning and comparison of technology or project options in a cost-benefit analysis framework;
- Serve as a user-friendly, in-country communication and workshopping tool; and
- Run on conventional software and produce user-friendly outputs.

In addition, the limited capacity and availability of power transmission and distribution systems have been identified as a constraint to the development of power projects, as well as the development of stranded gas assets within the region. To this extent, **Power Africa will assist with the improvement of existing transmission and distribution infrastructure and operations, as well as the development of new grid infrastructure.**

**An Integrated Gas Economy Planning Tool is recommended to be developed for each country and region.** The focus of the tool will be on quantifying current and future market and supply options, and will be designed to:

- Enable detailed country-specific gas and gas-to-power planning;
- Match different power generation, transmission, and distribution technologies/options/projects with electricity and other energy demands;
- Simulate energy tariffs and their effects;
- Measure investment returns;
- Measure MW generated per project/initiative/investment;

## Improving the enabling environment is key to unlocking the full potential of sub-Saharan gas-to-power markets.

Regulatory and policy, finance, transaction advisory, and capacity-building interventions are recommended to be phased as follows:

- Determine and enable near and long-term gas market opportunities (demand);
- Match these markets to appropriate gas supply (source and delivery method) options;
- Develop appropriate mitigation measures for the various risks identified;
- Prioritize the matched demand-supply opportunities; and
- Provide transaction implementation support.



Improving transmission and distribution networks in sub-Saharan Africa is critical to delivering new gas-fired power to homes and businesses across the continent.

## CHALLENGES

### OVERARCHING CHALLENGES

A fundamental challenge revolves around institutional or structural problems relating to the production, use, or regulation of gas. These challenges focus around opening the market through development of policy or regulation or frameworks for upstream and downstream developments. Interventions may take time to implement and may require significant technical expertise, but could provide a good return on investment as the revamped institutional framework may allow a higher level of certainty for private and public sector investors.

Common across sub-Saharan Africa is the existence of relatively small onshore gas discoveries, as well as relatively low levels of gas demand spread across different geographic areas. Advances and increasing utilization of technology such as CNG and small-scale LNG mean that there is the potential to both monetize small gas resources, as well as serve small and/or off-grid demand centers (not necessarily just in connection with small gas resources). These actions are already taking place in Nigeria and South Africa, and should be encouraged across the continent. The major benefit of this approach is that gas demand can be scaled up over time without the need for large, upfront, fixed capital investments.

When screening potential gas-related business opportunities, it is important to look at the whole natural gas-to-power value chain and to remember that this chain is only as strong as its weakest link. A plethora of parties fulfill the functions within this value chain, making the contractual arrangements challenging at times.

Moreover, most countries in sub-Saharan Africa have limited or no creditworthy off-takers, and/or constrained government support, which leads to an unavailability of guarantees. Power Africa has identified four main constraints that have delayed recent projects from reaching financial close, or caused projects to be abandoned altogether:

- Absence of or inadequate host **government support** (guarantees);
- Inability to obtain requisite **insurance** (political risk);
- Inadequate **security of gas supply, gas pricing, and contractual arrangements**; and
- **Power grid constraints.**

Financing challenges are one of the most fundamental and overarching concerns for infrastructure projects in sub-Saharan Africa. The short-term solution is the use of financial guarantees by governments and state-owned entities, to ensure the flow of money along the gas chain is guaranteed and supports the integrity of the physical gas chain. However, in the longer term, these fundamental issues, particularly the insolvency of many African utilities, will need to be resolved.

Power Africa, with on-the-ground transaction advisors who are in regular contact with all relevant stakeholders, is extremely well positioned to assess project risks and barriers, and propose solutions to mitigate them.

### COUNTRY AND REGIONAL CHALLENGES

For the countries we have defined as having developed gas reserves (Nigeria, Ghana, and Côte d'Ivoire), the fundamental problems tend to revolve around the updating of regulation and policy to fit the current requirements. In Nigeria, the Gas Master Plan is out of date and requires fundamental updates to ensure streamlining, relevancy and correct implementation. In Ghana, the role of multiple state entities and regulators in the gas industry has caused confusion and delayed progress. Clarity on the role and reach of regulators would be helpful. Côte d'Ivoire has recently updated legislation, which may create uncertainty in the near term.

For Mozambique, Tanzania, and Senegal, with some existing developed (as well as discovered but undeveloped) gas reserves and significant LNG export projects on the horizon, the main interventions are addressing the

challenges caused by these large discoveries and their exports. Since 2014, when oil prices began to fall, project economics in Mozambique and Tanzania have changed significantly, yet the export projects and upstream fiscal regimes have not been amended. This discrepancy will be a fundamental challenge if not addressed. For Senegal, the challenges include a unitization agreement with Mauritania prior to commercialization. Subsequently, Senegal will need to draft legislation to address its new potential exporter status.

For South Africa, having the largest existing power consumption per capita to go with limited gas resources, there are very different fundamental challenges. Gas supply and a clear, structured, and purposeful national policy of how to plan gas supply are required.

The ambitious target of up to 16,000 MW is based on the projects that could likely reach financial close by 2030, taking into consideration:

- The existing constraints in each of these countries; and
- What Power Africa could potentially do in this period to assist in alleviating these constraints.

## REGIONAL DYNAMICS

Within Africa's energy sector, few countries operate in isolation. To fully appreciate the challenges and opportunities in each of the nine focus countries, it is important to understand their position within their regional contexts. These regional dynamics play a significant role in the approach that must be taken to reach the objectives of this *Gas Roadmap*.

West Africa is the most mature oil and gas region in sub-Saharan Africa. However, within each country in the region there is wide variation in the scale of gas resources, demand potential, market development, and energy integration with neighboring countries. Theoretically, **West Africa could become energy self-sufficient from a gas and gas-to-power perspective.** Based upon the volume of proven reserves, and expected growth rates for gas-fired power generation, gas supply should not be a constraint in the region.



The 430 MW Azito power plant in Abidjan delivers a quarter of Côte d'Ivoire's baseload electricity generation to the national power utility. Photo: Globeleq

However, on a realistic and practical level, to achieve national and regional self-sufficiency through regional interdependence, the commercial fundamentals of the gas and gas-to-power sector in each country need to be robust and reliable on a sustainable, long-term basis. The energy sectors of many West African countries have not yet proven to meet these criteria.

In contrast to West Africa, only moderate volumes in East and Southern Africa are being commercially produced at present. The much larger offshore gas resources discovered are yet to reach commercial production. However, significant progress is being made, particularly in Mozambique where the 3.4 Mtpa Coral floating liquefied natural gas (FLNG) project has reached Final Investment Decision (FID), and the 12 Mtpa Mozambique LNG project is also making noteworthy steps towards FID.<sup>11</sup>

**The development of these upstream gas projects, and the resultant revenue flow to governments from its share of the resources and tax, will be transformative for countries in East and Southern Africa.**

While interventions in the Nigerian and Ghanaian markets could deliver successful outcomes relatively quickly, thanks to existing and planned gas and gas to power infrastructure and more mature gas markets, results in other markets will take longer to realize. The potential impact of interventions also varies across each country. Across all countries examined as part of this *Gas Roadmap*, interventions in the gas sector should have a significant positive effect on power sector development.

11 <https://www.reuters.com/article/anadarko-petrol-Ing-edf/anadarko-agrees-mozambique-Ing-sale-banks-discuss-finance-terms-idUSL8NIQA7U4>

## WEST AFRICA (7,749 MW GOAL)

The West African countries considered within this *Gas Roadmap* (**Nigeria, Ghana, Côte d'Ivoire, and Senegal**) have proven gas reserves that are in production, ranging from large volumes in Nigeria to negligible volumes in Senegal. Nigeria has the largest proven gas reserves in sub-Saharan Africa, as well as LNG export facilities. Nigeria has been a major player in the LNG business for over 20 years, but has been unable to harness additional gas resources to solve domestic or regional power generation deficiencies. Ghana and Côte d'Ivoire have more modest reserves, and both are in the process of establishing LNG imports to supplement indigenous production to meet a growing need for downstream gas demand for power generation. The recent discoveries in Senegal are of a scale and cost that will need access to international markets through LNG to warrant commercial development.

Looking forward, this diversity creates the possibility for increased regional integration. For example:

- There would be operational efficiency and shipping cost advantages by supplying LNG within the region.
- A small-scale LNG hub-and-spoke distribution business could be developed to supply smaller parcels of LNG to distributed power generation facilities.
- The existing West Africa Gas Pipeline (WAGP) is available to flow gas from Nigeria to Benin, Togo, and Ghana. There is both the opportunity to reverse flow the line to move gas within Ghana and from Ghana to Nigeria if additional Ghanaian resources are developed, or if Ghana moves forward with an LNG import project with substantial surplus capacity. The WAGP could also be extended to Côte d'Ivoire. Increased utilization of the pipeline requires solutions to payment and supply inconsistencies.
- In the downstream power sector, investment in power generation capacity and transmission reinforcement within the West Africa Power Pool (WAPP) provides the opportunity for increased integration.

West Africa could become energy self-sufficient from a gas and gas-to-power perspective.

In Nigeria and Ghana, the gas-to-power chain is not functioning on an economically sustainable basis due to issues such as revenue collection at the customer level, revenue not flowing back up the chain to gas suppliers, inadequate infrastructure, and the security of gas supply. Gas supply issues and contractual agreements not being honored by producers have also impacted the commercial viability and operational performance of the WAGP— influencing the decision of those countries needing to import gas to advance LNG import facilities to ensure access to a potential range of gas supply sources, and therefore not to be reliant upon a single source. The historical underperformance of WAGP influenced the decision to pursue LNG imports in Côte d'Ivoire rather than seeking to extend WAGP. While the LNG import option is being developed, further work can be done on resolving the issues causing the underperformance of WAGP.

**A significant private sector and commercial drive will be required to realize gas-related opportunities.** Often, the first movers to take advantage of regional opportunities are highly entrepreneurial and nimble players that can see and implement opportunities early, perhaps at the smaller end of the investment and infrastructure scale. A good example, albeit outside of Africa, is New Fortress Energy, a U.S. company that is establishing a small-scale LNG hub-and-spoke distribution business to fuel distributed power stations across the Caribbean.

Governments will also play an enabling role, but will be focused on ensuring the sustainable delivery of energy in their own jurisdictions before tackling a broader agenda.

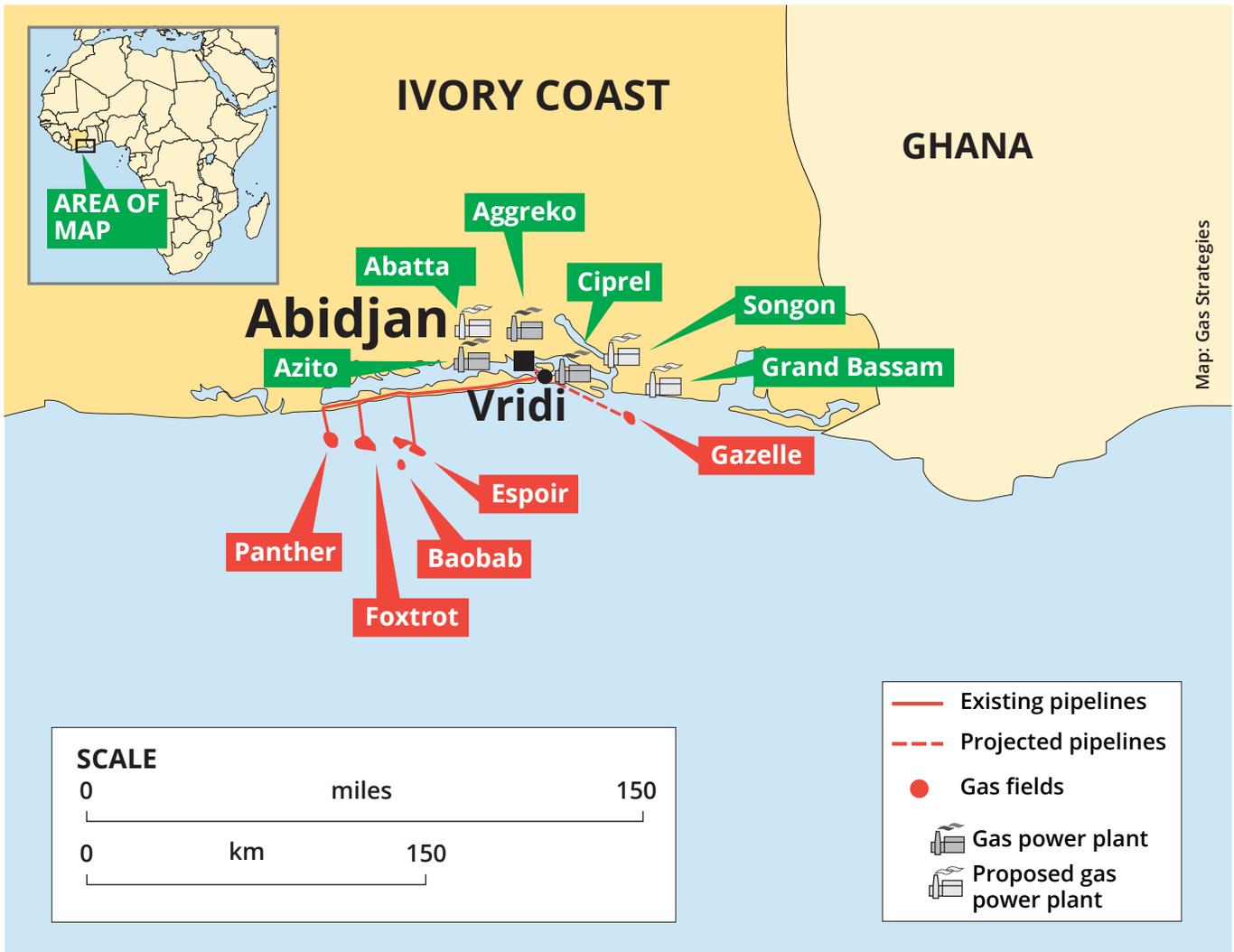
The following pages outline intended Power Africa interventions in West Africa.

## CÔTE D'IVOIRE (1,271 MW)

Gas is, and will continue to be, an important part of Côte d'Ivoire's energy mix. Additional investment in securing supply is critically needed if a portion of the generation capacity targets are to be met through gas-fired plants. There are significant opportunities for the supply of imported LNG, as well as the development of import and regional midstream infrastructure. It will, however, be difficult to balance proposals for large gas import and coal-fired power generation projects with a desire for additional domestic gas resource development. As with other countries in the region, it will also be a challenge to balance the ambitions of neighboring countries to become power exporters within the WAPP.

As the development of both the upstream and downstream components of gas projects are intricately linked, interventions should target four areas across the gas-to-power value chain:

- Upstream (local gas field and gas supply contract);
- Local gas infrastructure (LNG imports and gas pipe lines);
- Regional gas infrastructure (including WAGP); and
- Gas markets (power generation and gas markets, which could help to anchor the demand, including LNG re-export).



## CÔTE D'IVOIRE GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	2,172 MW (1,298 MW is from gas and/or liquid fuels)	Additional gas generation capacity: 2019: 372 MW 2020: 277 MW 2025: 272 MW 2030: 350 MW <b>Total: 1,271 MW</b>	Assist with the development of a PPA that reflects the challenges of an LNG-to-power project, rather than a domestic gas-to-power project.  Increase access to on-grid power through the development of transmission and distribution infrastructure.
<b>Gas Supply</b>	<p>Despite an existing developed gas resource (estimated at 1 Tcf) and recent offshore finds, there is a current gas deficit (estimated at 0.35 Tcf/year).</p> <p>The single biggest constraint to increasing gas-fired generation is limited gas supply. Indigenous gas finds have not kept pace with declining existing reserves, and increasing demand.</p>		<p>Increase gas supply through facilitating the importation of LNG. This will require not only the supply of LNG, but also the development of the appropriate import infrastructure.</p> <p>Explore options for smaller scale imports.</p> <p>Explore options for cooperation with WAPP to justify larger scale imports for power generation.</p> <p>Assist with increasing indigenous gas production through supporting:</p> <ul style="list-style-type: none"> <li>• Increase in exploration.</li> <li>• Acceleration of the progression from gas finds to first gas production.</li> <li>• Identify solution and off-taker for identified potential gas offshore development.</li> </ul>
<b>Gas Infrastructure</b>	Limited pipeline infrastructure linked to existing power plants.		Assist with the development of off-grid solutions, which may include consumer and fleet vehicle use of CNG (compressed natural gas), and LNG, which could be linked to a LNG-to-power project.
<b>Regulatory Environment</b>	<p>Liberalized electricity sector. CI-ENERGIES, the public utility company, has been unbundled to increase competition.</p> <p>IPPs are allowed to sell power direct to the grid and guidelines exist on power marketing and distribution.</p>		<p>Assist with the developing of LNG policy and regulation.</p> <p>Assist with developing the appropriate regulatory and fiscal regimes and incentives to increase indigenous production of gas.</p>

## RECOMMENDATIONS FOR INTERVENTION IN CÔTE D'IVOIRE

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Update regulations and policies to fit the current requirements to support the increase of gas in the energy mix, with reference to LNG supply.</li> <li>• Create certainty in the near term with regards to recently updated legislation, by enabling implementation.</li> <li>• Review of existing Production Sharing Contracts to ensure appropriate incentives for exploration and production.</li> <li>• Review the local and regional gas and power price markets with a view to assist in addressing any gaps.</li> </ul>	<ul style="list-style-type: none"> <li>• Fund upstream developments (greenfields), gas processing facilities, pipelines, LNG import terminal(s) and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Provide commercial assistance to design the most appropriate LNG-to-power project structure.</li> <li>• Develop additional local gas resources.</li> <li>• Independent benchmarking of gas supply alternatives (domestic gas, regional gas, and LNG imports);</li> <li>• Provide independent review of the most relevant project structures.</li> <li>• Develop a PPA that reflects the challenges of an LNG-to-power project, rather than a gas-to-power supply chain.</li> <li>• Improve energy efficiency through the repair or rehabilitation of transmission and distribution lines.</li> <li>• Develop off-grid gas and gas-fired power projects.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of existing generation plants (300 MW)</li> <li>• Development of new generation plants (600 MW)</li> <li>• LNG import terminal</li> <li>• Conversion of existing plants from liquid fuels to gas</li> <li>• Small-scale LNG projects</li> </ul>

## GHANA (1,555 MW)

Gas is a central part of the energy mix in Ghana, and key to displacing more expensive oil products. Despite its indigenous gas reserves and pipeline connection to Nigeria, Ghana may require LNG imports to meet projected power demand growth. Due to its relatively large population of approximately 28 million, and its stable security and political regime, Ghana has been an attractive destination for foreign direct investment in recent years. Its economy is projected to grow by 8 percent in 2018.<sup>12</sup> For gas-fired power and industrial development plans to be successful, Ghana will

need to synchronize gas infrastructure construction with power plant and LNG import terminal plans, as well as coordinate site selection with supply locations.

Power Africa has had some success in intervening in fundamental challenge issues in Ghana, including delivering a study into the institutional and regulatory reforms in the gas sector and supporting the government on identifying the optimal use of Ghana's indigenous gas supplies.



<sup>12</sup> *African Economic Outlook 2017*, <http://www.africaneconomicoutlook.org/en/country-notes/ghana>

## GHANA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	4,751 MW (1,718 MW from gas)	Additional gas generation capacity: 2019: 195 MW 2020: 110 MW 2025: 500 MW 2030: 750 MW <b>Total: 1,555 MW</b>	Assist with improving the availability of existing generation capacity. Assist with converting existing liquid fuel powered facilities to gas. Assist with accelerating gas supply to large-scale combustion turbine projects. Assist in conversion of open cycle power plants to combined cycle, to improve thermal efficiency. Assist in expanding the transmission and distribution network to increase electrification rates and increase demand. Assist with prioritizing PPAs to determine which projects are viable and could move forward.
<b>Gas Supply</b>	Connected to West African Gas Pipeline. Supply over the last five years has varied from erratic to non-existent due to payment disputes, technical issues with pipeline and upstream gas supply issues in Nigeria. Indigenous gas supply from Jubilee field. Additional local resources are being developed. Indigenous production is expected to average approximately 330 MMscfd until 2030 once these fields are on-stream. Ghana's natural gas reserves stand at 1.9Tcf.		Assist with development of LNG importation (supply and infrastructure). Assist in the development and commercialisation of mini LNG import facilities to provide LNG in the short term until commercial scale LNG facilities become available. Assist with developing a 220km (137 mile) pipeline from Takoradi in Western Ghana to the second power generation hub in Tema, East of Accra. Assist with inter-connection of Ghana Gas Transmission System with the West African Gas Pipeline System.

## GHANA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Gas Infrastructure</b>	<p>Gas supply from the Jubilee field is processed at the Atuabo gas processing plant and transported to Takoradi via an onshore pipeline. Gas supply from the TEN fields will utilize the same infrastructure. Sankofa gas production will be processed offshore and delivered to Atuabo.</p>		
<b>Regulatory Environment</b>	<p>Four regulatory authorities have jurisdiction over various parts of the natural gas sector, namely the Petroleum Commission (PC), Energy Commission (EC), Public Utilities Regulatory Commission (PURC) and the National Petroleum Authority (NPA). In addition, three state institutions, the Ghana National Petroleum Corporation (GNPC), the Ghana National Gas Company (GNGC) and the Bulk Oil Storage &amp; Transportation Company Limited (BOST) are involved in the country's natural gas sector operations with respect to both commodity and infrastructure management. The existence of multiple regulators and state gas companies has created occasional confusions, regarding approval, operating jurisdiction and permitting procedures for potential investors in the sector.</p>		<p>Assist with the institutional and regulatory reforms required to simplify and streamline the role of state institutions to provide for more efficient decision making and acceleration in investment.</p> <p>Assist with the development of a Natural Gas Pricing Policy and determination of a Gas Prices on a regular basis through the use of a Gas Pricing Model.</p> <p>Provide standard templates of Gas Supply Agreement and Gas Transportation Agreement along with capacity building in the commercial structuring of gas supply chain contracts.</p>

## RECOMMENDATIONS FOR INTERVENTION IN GHANA

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>Update regulations and policies to fit the current requirements to support the increase of gas in the energy mix.</li> <li>Create a simplified and streamlined protocol for more efficient decision-making among each of the various state entities and regulators to provide certainty regarding approval and permitting procedures for potential investors in the sector.</li> <li>Review and draft a new Natural Gas Pricing Policy (NGPP) for adoption.</li> <li>Develop a Gas Pricing Model (GPM) to enable a regular update of gas prices.</li> </ul>	<ul style="list-style-type: none"> <li>Improve revenue collection, performance, and financial capacity/creditworthiness of utilities.</li> <li>Enable utilities to perform specified roles, finance new projects and collect revenues.</li> <li>Fund upstream developments (brown- and greenfields), gas processing facilities, pipelines, LNG import terminal(s), and downstream projects utilizing gas.</li> <li>Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>Develop a Revenue Waterfall System to allocate the volatile/scarc cash generated among the various entities in the gas value chain, to reduce the burden on the state exchequer.</li> <li>Review the proposed LNG import projects to determine, among other things, procurement process, optimal location, commercial structure, and requirements for LNG volumes over time.</li> <li>Develop gas transmission and distribution infrastructure.</li> <li>Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>Development of new generation plants (800 MW)</li> <li>WAGP Reverse Flow Project</li> <li>Takoradi-Tema Onshore Pipeline project</li> <li>LNG import terminal(s)</li> <li>Conversion of existing plants from liquid fuels to gas</li> </ul>



The *John Agyekum Kufuor*, a floating production storage and offloading unit operated by the Italian firm Eni, will process natural gas from Ghana's Sankofa field as part of the Offshore Cape Three Points project. Photo: Eni

## NIGERIA (4,490 MW)

Owing to its substantial resources, infrastructure, and demand for both gas and power, Nigeria represents perhaps the biggest opportunity to add new generation capacity (MW). Up to 1,400 MW could achieve financial close by the end of 2018, with 4,700-6,800 MW of capacity in the near-term project pipeline.<sup>13</sup> To complete the value chain, there will need to be parallel investment in gas supply and transportation, assisted by improvements to gas and electricity transmission and distribution systems. Nigeria still flares significant quantities of gas, sufficient to fuel 6 GW of power at a 70 percent load factor. The Federal Government of Nigeria launched the Nigerian Gas Flare Commercialization Program (NGFCP) in 2017, which seeks to attract competent third-party off-takers to invest in capturing and utilization of gas flares. With an investment of \$3 billion, the NGFCP could generate approximately 2.5 GW of power. Power Africa began supporting the NGFCP in 2017.

Nigeria is an attractive country for rapid power sector development due to:

- Abundant gas reserves (over 180 Tcf);
- Easy to develop (physically) incremental gas supply;
- Large concentrations of population/commerce currently with latent demand not met by grid based electricity, hence any new power generation should be swiftly absorbed by consumers;
- High (relative to other SSA) urban GDP/capita;
- A gas transmission network serving the south that could be expanded to serve other regions;
- A developed, but inadequate power transmission system; and
- A liberalized, but inadequate power distribution system.

In addition, there is the opportunity to rehabilitate and improve the performance of legacy infrastructure, such as pipelines and generation and transmission assets, that were in government agency control and severely underfunded.



<sup>13</sup> Power Africa Tracking Tool

## NIGERIA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	12.5 GW (9.25 GW gas-fired), of which 3.5–5 GW is typically available due to factors such as grid unavailability, insufficient gas supply and unscheduled maintenance.	Additional gas generation capacity: 2019: 1,040 MW 2020: 1,050 MW 2025: 1,200 MW 2030: 1,200 MW <b>Total: 4,490 MW</b>	<p>Assist with the rehabilitation and improvement of existing generation as well as pipeline infrastructure.</p> <p>Assist with providing the requisite guarantees to enable investment in energy infrastructure.</p> <p>Assist with increasing the reliability of the current transmission and distribution system.</p> <p>Assist in upgrading the transmission network such that it can handle 20 GW by 2030.</p>
<b>Gas Supply</b>	<p>Abundant gas reserves (over 180 Tcf) as well as easy to develop incremental gas supply.</p> <p>Sabotage in the Niger Delta—through which nearly all major gas supply pipelines traverse—is providing a spur to the development of other solutions such as CNG and LNG to deliver gas to demand centers.</p>		<p>Assist with delivery of LNG to Lagos from either domestic or international sources.</p> <p>Assist with the commercialization of gas flares.</p> <p>Assist with the development of willing seller / willing buyer contracts. The current Gas Aggregation Company Nigeria contracts—none of which have been put into effect—do not (in the opinion of the upstream gas seller) balance risk and reward.</p> <p>Assist with developing pricing structures for gas.</p>
<b>Gas Infrastructure</b>	<p>Upstream infrastructure has largely been built by IOCs, in most cases it is well maintained.</p> <p>Existing pipelines to gas load centers, but prone to sabotage.</p> <p>Connected to the West African Gas Pipeline (WAGP).</p>		<p>Assist with the development of non-pipeline transportation and commercialization solutions such as CNG and LNG (truck, rail, barge, container, etc.), as well as gas distribution networks in load centers.</p>
<b>Regulatory Environment</b>	The Department of Petroleum Resources (DPR) is the regulator for the oil & gas sector. The regulatory framework has been reviewed, with a new Gas Policy in place and a revised framework for addressing increased production of gas from gas flares.		<p>Assist with updating the Gas Master Plan.</p> <p>Assist regulator to establish and maintain a commercial tariff that protects the interests of the consumer while covering operating costs to ensure system maintenance and to give a reasonable rate of return to those prepared to invest in the gas-to-power infrastructure.</p>

## RECOMMENDATIONS FOR INTERVENTION IN NIGERIA

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Update regulations and policies to fit the current requirements to support the increase of gas in the energy mix.</li> <li>• Update the Gas Master Plan to ensure streamlining, relevancy and correct implementation.</li> </ul>	<ul style="list-style-type: none"> <li>• Improve the financial capacity/creditworthiness of utilities.</li> <li>• Restore the power transmission network to the 7 GW it was designed to transmit.</li> <li>• Enable utilities across the value chain to cover costs, finance new projects and collect revenues.</li> <li>• Fund upstream developments (brown- and greenfields), gas processing facilities, pipelines, LNG export terminal(s), and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Improve the revenue collection and performance of utilities along the gas value chain (including DISCOs.)</li> <li>• Encourage move towards willing seller/willing buyer contracts to effectively balance risk and reward.</li> <li>• Encourage optimal use of available gas supply to the most efficient power generators in the short term to maximize power output.</li> <li>• Advance the upgrade and development of new power transmission infrastructure on the back of new generation projects.</li> <li>• Advance the flare gas monetization program.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of existing generation plants (1,000 MW)</li> <li>• Development of new generation plants (2,290 MW)</li> <li>• Flare gas monetization projects</li> <li>• Conversion of existing plants from liquid fuels to gas</li> </ul>

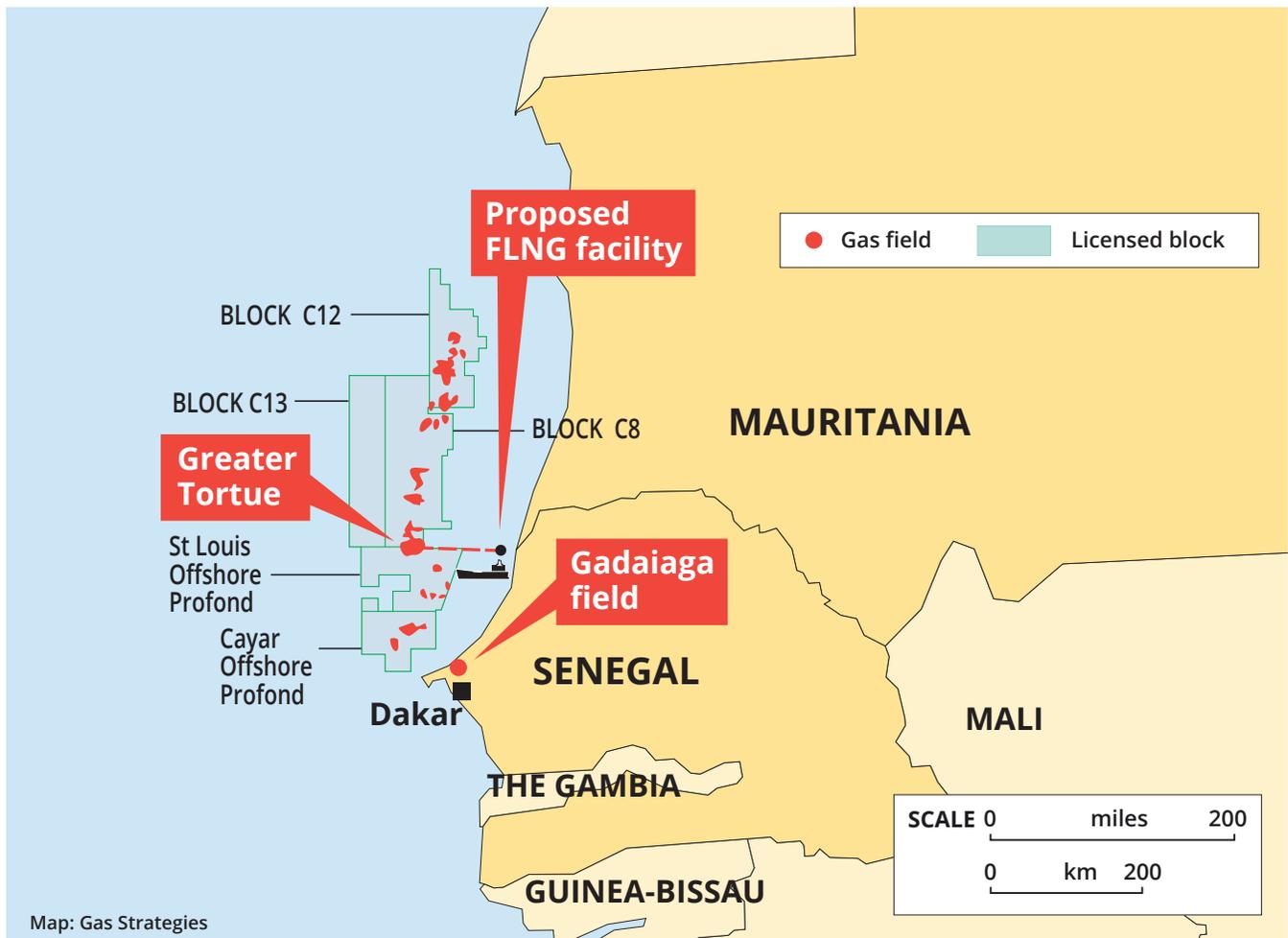


With almost 8 billion cubic meters of gas flared annually, Nigeria is the seventh-largest gas flarer in the world. Over 130 flare points have been identified that flare over one billion standard cubic feet per day. The Nigeria Gas Flares Commercialization Program (NGFCP), supported by Power Africa, is attracting third-party off-takers to invest in capturing and utilizing of gas flares. With an investment of \$3 billion, the NGFCP program could generate approximately 2.5 gigawatts of power, and eliminate 20 million tons of CO<sub>2</sub> emissions per year.

## SENEGAL (433 MW)

Senegal is one of the most stable economies in Africa, with GDP growth in 2015 and 2016 at approximately 6 percent.<sup>14</sup> In the last few years, Senegal has attracted considerable interest and investment from leading international oil and gas companies. The recent discovery of large gas resources has the potential to be transformational for Senegal's economy. The specific situation of these discoveries—operationally complex and high-cost—will mean that without export development as the main commercialization option, it is unlikely that gas can enter the domestic market. Development of these resources is likely to take around ten years. Demand has not yet been

quantified, though if the offshore gas is monetized successfully, it is possible that new, gas intensive industry will be established to take advantage of the gas supply. In addition to new build projects, there are also opportunities to convert existing plants to gas. Power Africa is developing a discrete Gas Roadmap for Senegal, to be finalized by the end of 2018, to determine the potential demand and route to market for gas. Since local gas will not be available until 2025, opportunities exist for the importation of LNG to ease the transition to gas while also reducing the generation cost of electricity. The infrastructure developed in the near term for importation could then be utilized for domestic gas in the longer term.



<sup>14</sup> World Bank, <http://data.worldbank.org/indicator/NY.GDPMKTRPKD.ZG?locations=SN>

## SENEGAL GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	750 MW (the majority of which is liquid fuel fired)	Additional gas generation capacity: 2019: 33 MW 2020: 0 MW 2025: 250 MW 2030: 150 MW <b>Total: 433 MW</b>	Convert existing generation facilities to gas in order to enable increased gas supply into the country.
<b>Gas Supply</b>	Historically small volumes produced to feed domestic demand from the industrial and power sectors. The recent discovery of large gas resources has the potential to be transformational for Senegal's economy. Without an export development as the main commercialization option, it is unlikely that this gas can enter the domestic market.		Assist with negotiations between the Senegalese government and gas field owners to enable the local resources to be developed and make gas available to the local and regional market.
<b>Gas Infrastructure</b>	With large-scale commercialization of the Tortue gas prospect expected to take multiple years, Senegal has also considered the deployment of an FSRU as an interim measure. Such a project is likely to be integrated with power generation, either new or existing, to ensure stable demand for the gas.		Assist with development of LNG import project while local resources are being developed to build a market for gas and provide capacity to accept the domestic share from export projects.
<b>Regulatory Environment</b>	There is no overarching strategic framework or "master plan" that guides gas sector development. The government has announced a series of reforms to ensure effective management. The Petroleum Act is considered in need of reform to ensure that Senegal's upstream industry is operating at international standards.		Assist with the development of the fiscal and regulatory frameworks required for the development of indigenous gas supply.  Provide support to evaluate the economic impact and benefits of a range of different scenarios for industry development.

## RECOMMENDATIONS FOR INTERVENTION IN SENEGAL

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Strengthen the regulatory and fiscal structures required for upstream development.</li> <li>• Draft legislation to address Senegal's new potential exporter status.</li> <li>• Develop a communication strategy and outreach campaign to provide clarity on the plans for development and the potential benefits for all members of society.</li> </ul>	<ul style="list-style-type: none"> <li>• Fund upstream developments (brown- and greenfields), gas processing facilities, pipelines, LNG export terminal(s), liquification facilities and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Conclude a unitization agreement with Mauritania to ensure commercialization of Tortue field.</li> <li>• Assist with securing long-term gas agreements as well as financing of Tortue.</li> <li>• Negotiate with upstream partners and creation of regulation that safeguards the delivery of Senegalese gas for its domestic market as well as export.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of existing generation plants (33 MW)</li> <li>• Development of new generation plants (250 MW)</li> <li>• LNG import terminal</li> <li>• Conversion of existing plants from liquid fuels to gas</li> </ul>



With development of the Tortue field expected to take multiple years, Senegal has considered the deployment of a floating storage and regasification unit (FSRU) to provide interim supply for existing or new power projects, which can also help build a solid market for gas. Photo: Danny Cornelissen

## EAST AFRICA (1,720 MW GOAL) AND SOUTHERN AFRICA (4,365 MW GOAL)

The East and Southern Africa focus countries are grouped together in this **Gas Roadmap** as they present significant and mutually beneficial gas markets and gas supply options for intra-basin or regional trade, and, if not coordinated, could be in direct competition. In addition, East and Southern Africa are planning to link their respective power pools (EAPP and SAPP) through the Zambia-Tanzania-Kenya (ZTK) interconnector, with World Bank support. Unlike the Eastern Coast of the region, Angola is currently a discreet gas system with supply that is not linked to other regional demand centers. In the future, Angola could supply gas to Southern Africa through LNG exports or power trade through the Angola-Namibia interconnector if the needed infrastructure was built.

In contrast to West Africa, development in the East African and Southern African gas sectors to date has been on a limited scale. Tanzania's Mnazi Bay and Songo Songo fields, and Mozambique's Pande and Temane fields, currently produce relatively small gas volumes. The significant gas resources discovered offshore in 2010 are yet to reach commercial production.

These offshore resources in both Tanzania and Mozambique are particularly sizable, with reserves estimated at 40 Tcf and 123 Tcf respectively.<sup>15</sup> Given the scale of the reserves and their associated development costs, upstream development will need to be underpinned by a sizable commitment of demand offtake, potentially made up of a combination of domestic consumption and exports (e.g. via LNG or pipeline). Without the anchoring of demand, development of the vast resources may be challenging.

**The development of these upstream projects, and the resultant revenue flow to governments from their share of the resources and tax, could be transformative for both Tanzania and Mozambique.**

As such, both countries will be pursuing their own development agendas.

In doing so, LNG and/or pipeline exports from the projects may potentially compete for the same set of buyers as there is no current agenda of collaboration between the countries.

Development of upstream gas projects will be transformative for countries in East and Southern Africa.

As a country seeking to import additional gas resources, to add to its existing gas pipeline imports from Mozambique, **South Africa is well located as a destination market** for a portion of the gas. The most recently available version of South Africa's Integrated Resource Plan (IRP), released in 2016, outlines the potential for 7,320 MW of gas-fired generation as part of the energy mix by 2030. Of this, 3,726 MW has already been allocated to various projects by South Africa's IPP office, including 3,000 MW in LNG-to-power commitments, 600 MW for gas-to-power projects, and 126 MW for domestically produced gas. South Africa's demand is therefore dependent on gas-fired power generation being developed, and the associated import infrastructure being in place.

Given that much of the region's supply potential is located within Tanzania and Mozambique while demand is centered in South Africa, a natural opportunity exists for trade to bridge these imbalances. Based on the distances and volumes involved, governments should consider the various means for trade, including in its natural state via pipeline, liquefied and shipped as LNG, trucked as CNG, or converted into electricity and transmitted via an interconnector. Given the relatively low average prices of gas across the world, securing regional markets for gas trade (either in the form of LNG or, if deemed feasible, via pipeline) has potentially become more relevant to minimize transportation costs and maximize project revenue.

Sale of the region's gas reserves are expected to be at a commercial and internationally competitive price. The upstream development in Tanzania and Mozambique will largely be in the control of the private sector project developers, and buyers will therefore have to compete with alternative markets/buyers.

The following pages outline recommended interventions in East Africa and Southern Africa. For more details on analysis around Southern Africa's regional trade potential, please refer to Power Africa's **Southern Africa Gas Roadmap**.

<sup>15</sup> Wood Mackenzie upstream data tool <https://www.woodmac.com/research/products/upstream/upstream-data-tool/>

## KENYA (550 MW)

There are no exploited gas deposits in Kenya, and gas does not currently feature as a fuel in electricity generation. There have been recent onshore and offshore gas discoveries, a gas pipeline from Tanzania to Kenya is proposed, and there were plans (now abandoned due to the discovery of indigenous gas) for a new gas-fired power station to the south of Mombasa. In 2014, gas was discovered onshore near Wajir; and there are early plans to build a 500 MW gas-fired plant nearby.<sup>16</sup> In addition, there are liquid fuel plants with total installed capacity of 460 MW that are designed to be convertible to run on natural gas in the future. Kenya will need to resolve its competing plans for new capacity from gas, coal, geothermal, wind and solar to determine how natural gas fits into their generation plans.

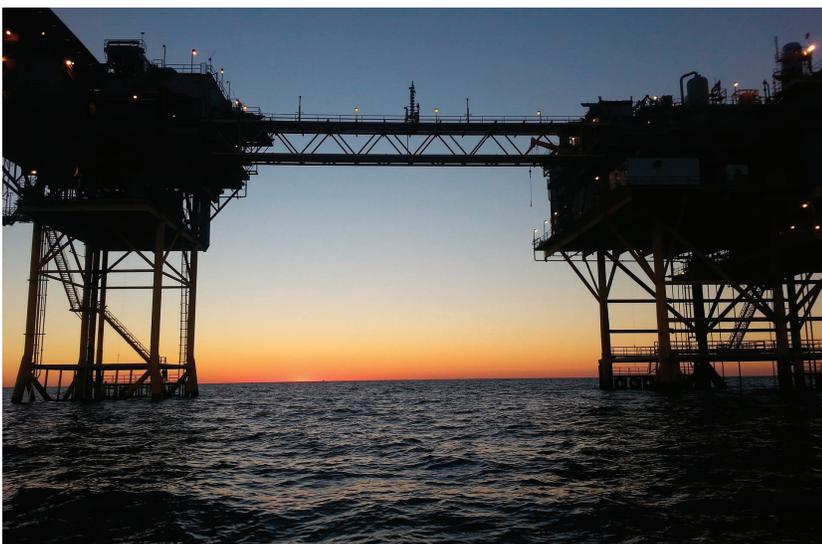
The country does not yet have proven gas reserves but exploration is going on in various areas (blocks). The National Energy and Petroleum Policy cites the following challenges of gas to power development:

- Lack of a legal, regulatory, and fiscal framework for natural gas development, production, and export options;

- Lack of infrastructure for handling natural gas, such as natural gas liquefaction plants and pipelines;
- Lack of facilities to exploit natural gas reserves, e.g., petrochemical plants, and fertilizer plants; and
- Lack of gas master plan.

To address the challenges, the National Energy and Petroleum Policy proposes the following policies and strategies:

- Develop and implement a gas master plan;
- Establish a transparent and efficient legislative framework;
- Attract investment in natural gas by promoting private sector participation in all parts of the gas value chain;
- Adopt a segmented fiscal structure covering the upstream, midstream, and downstream segments to facilitate efficient use of capital and Government oversight;
- Develop infrastructure to supply residential and commercial consumers with clean and reliable natural gas;
- Facilitate construction of natural gas infrastructure for electricity generation and other uses; and
- Apply CNG technology for transport, starting with public transport initially on pilot basis in areas with supply of natural gas.



Recent offshore discoveries may boost Kenya's capacity to develop gas-to-power projects.

<sup>16</sup> <http://www.businessdailyafrica.com/markets/Ministry-plans-500MW-natural-gas-plant-in-Wajir/539552-2454622-g3vufz/index.html>

## KENYA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	2,333 MW (currently no gas-to-power plants)	Additional gas generation capacity: 2019: 0 MW 2020: 50 MW 2025: 250 MW 2030: 250 MW <b>Total: 550 MW</b>	Assist with development of Lamu gas-to-power project.
<b>Gas Supply</b>	Currently no exploited gas deposits in Kenya, though there have been recent onshore and offshore gas discoveries.		Assist with the development of the onshore discoveries in North East Kenya. Assist with LNG import options while local resources are being developed.
<b>Gas Infrastructure</b>	A gas pipeline from Tanzania to Kenya is proposed, as well as plans for a new gas-fired power station on the coast.		Assist with determining the economic feasibility of the proposed gas pipeline from Tanzania to Kenya.
<b>Regulatory Environment</b>	Well-developed IPP legislation and procurement frameworks.  Limited legislation with regards to the development of gas resources as well as the use of gas.		Assist with the development of the fiscal and regulatory frameworks required for the development of indigenous gas supply.

## RECOMMENDATIONS FOR INTERVENTION IN KENYA

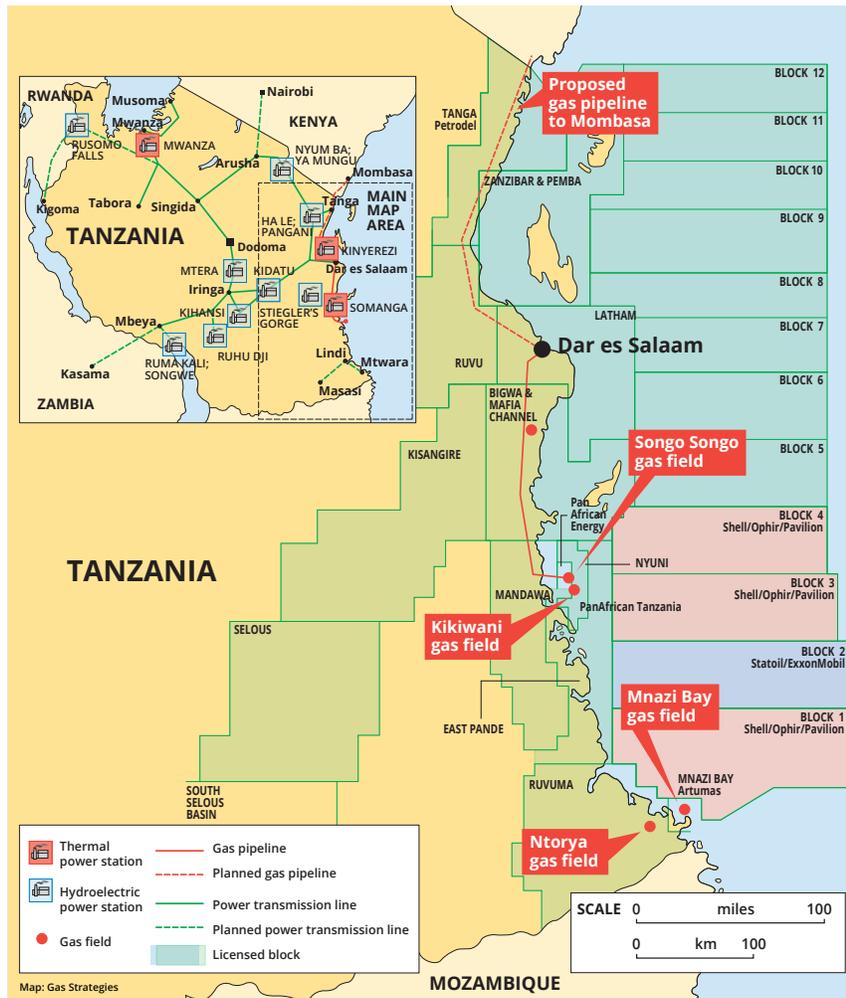
REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>Define the role of gas in the energy mix.</li> <li>Implement a standard framework for IPPs.</li> <li>Determine the affordability of imports.</li> <li>Complete policy and regulation on development of gas.</li> </ul>	<ul style="list-style-type: none"> <li>Fund expansion of the existing power grid.</li> <li>Strengthen the financial capacity and creditworthiness of state entities.</li> <li>Fund upstream developments (greenfields), gas processing facilities, pipelines and downstream projects utilizing gas.</li> <li>Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>Develop the onshore discoveries in northeastern Kenya.</li> <li>Determine economic feasibility of the proposed gas pipeline from Tanzania to Kenya.</li> <li>Assess opportunities for local markets for indigenous and imported gas use.</li> <li>Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>On- and offshore upstream projects</li> <li>Development of new generation plants (300 MW)</li> <li>LNG import project</li> <li>CNG projects</li> <li>Conversion of existing plants from liquid fuels to gas</li> </ul>

## TANZANIA (1,170 MW)

Tanzania has access to a range of energy resources, including hydro, coal, and gas. The country's long-term Power System Master Plan envisages a larger role for natural gas and coal in the future energy mix, with gas-fired power plant capacity anticipated to grow from 1,501 MW in 2015 to 4,915 MW in 2040.<sup>17</sup>

Tanzania already produces and commercializes some of its onshore and near offshore gas, and it is currently in the process of monetizing its reserves. It will be difficult for the country to attract foreign investment to develop the vast majority of identified resources—located deep offshore—

unless investment terms improve and competing requirements of petroleum and extractive industries laws are clarified. Supplying gas to the electricity utility, TANESCO, through the Tanzania Petroleum Development Corporation has variable cost implications for power generation and may increase Tanzania's corporate capital burn rate at a time when TANESCO does not want to incur unnecessary expenses. Tanzania needs a tariff regime for production, transportation, and sales of gas and power that reflects costs and profitability for developers, but that also is affordable and helps the economy develop.



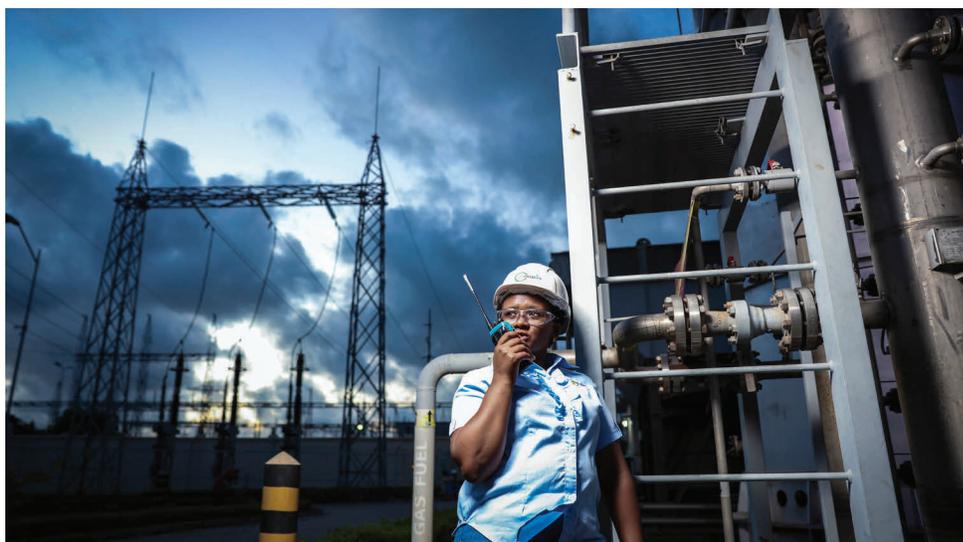
<sup>17</sup> Power System Master Plan 2016 Update, <https://mem.go.tz/power-system-master-plan/>

## TANZANIA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	1,560 MW (780 MW from gas and/or liquid fuels)	Additional gas generation capacity: 2019: 320 MW 2020: 300 MW 2025: 250 MW 2030: 300 MW <b>Total: 1,170 MW</b>	Assist with development of government guarantee structures as well as credit enhancement thereof.
<b>Gas Supply</b>	Gas Initially in Place is estimated as 55 Tcf. Two fields are in production, Songo Songo and Mnazi Bay, producing approximately 33 Bcf annually, of which 80% is for power generation.  The Final Draft Natural Gas Utilisation Master Plan (NGUMP) of September 2016 anticipates a total cumulative gas demand of 33.3 Tcf between 2016 and 2045 (19.1 Tcf domestic, of which 8 Tcf is for electricity; 14.2 Tcf export).		Support the development of pricing mechanisms for domestic gas. Pricing mechanisms will need to be developed specific to the end-use of the gas. Without a robust domestic gas pricing policy, the benefits of increased gas supply will not be maximized and spread across the economy.  Support the clarification of the extractives law as it applies to natural gas development to provide advice on developing better incentives for international investment in Tanzania's gas sector.
<b>Gas Infrastructure</b>	Four gas processing plants at Songo Songo (two), Mnazi Bay and Madimba. Pipeline from Songo Songo to Dar es Salaam as well as from Madimba Kinyerezi to Dar es Salaam.		Assist with the development of off-grid solutions, particularly CNG (compressed natural gas).  Assist with developing LNG liquefaction and export facility.
<b>Regulatory Environment</b>	Although legal and regulatory frameworks and the draft NGUMP are in place, these in themselves are not sufficient.		Assist with developing policies/ regulations for any new gas-based industries.  Review existing policies to ensure suitability for the planned growth in the gas/power sector.  Assist with completion of the of Host Government Agreement for the LNG export project.

## RECOMMENDATIONS FOR INTERVENTION IN TANZANIA

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Review regulations and policies to ensure suitability for the planned growth in the gas and power sector. New policies and regulations may be required for any new gas-based industries.</li> <li>• Develop pricing mechanisms for domestic gas. Pricing mechanisms will need to be developed specific to the end-use of the gas.</li> <li>• Develop, finalize, and implement policies and regulations to enable upstream developers to monetize the gas required to kick start domestic gas demand.</li> <li>• Develop the upstream fiscal regime framework.</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthen the financial capacity and creditworthiness of state entities.</li> <li>• Increase the power transmission capacity and reliability.</li> <li>• Monetize the major local discoveries through LNG exports.</li> <li>• Facilitate domestic supply from local resources.</li> <li>• Fund upstream developments (brown- and greenfields), gas processing facilities, pipelines, LNG export terminal(s), liquefaction facilities and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Review contractual terms to encourage further upstream exploration considering the lower oil price environment.</li> <li>• Review the full suite of commercial agreements for new generation projects to balance risk allocation and set a precedent and enable future gas-to-power developments.</li> <li>• Technical assistance to the government to develop the LNG export project. This assistance will unlock additional gas resources for the domestic market, which will in turn drive economic growth and gas-fired power generation.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of existing generation plants (300 MW)</li> <li>• Development of new generation plants (600 MW)</li> <li>• Liquefaction facility</li> <li>• Pipeline projects</li> <li>• CNG projects</li> </ul>



Coordinating activities at the Songas 180 MW Ubungo natural gas fired power plant in Tanzania. Through initiatives like Women in African Power and Engendering Utilities, Power Africa and USAID are committed to advancing opportunities for women in the African energy sector. Photo: Globeleq

## ANGOLA (600 MW)

Grid-connected power generation in Angola is a combination of diesel and hydropower, with less than 2 GW of installed capacity, leaving a considerable need for additional grid-connected power generation capacity.<sup>18</sup> The Government's plan is to go to 9.9 GW by 2025, of which 1.9 GW will be gas, requiring significant investment in transmission infrastructure, as well as generation.<sup>19</sup>

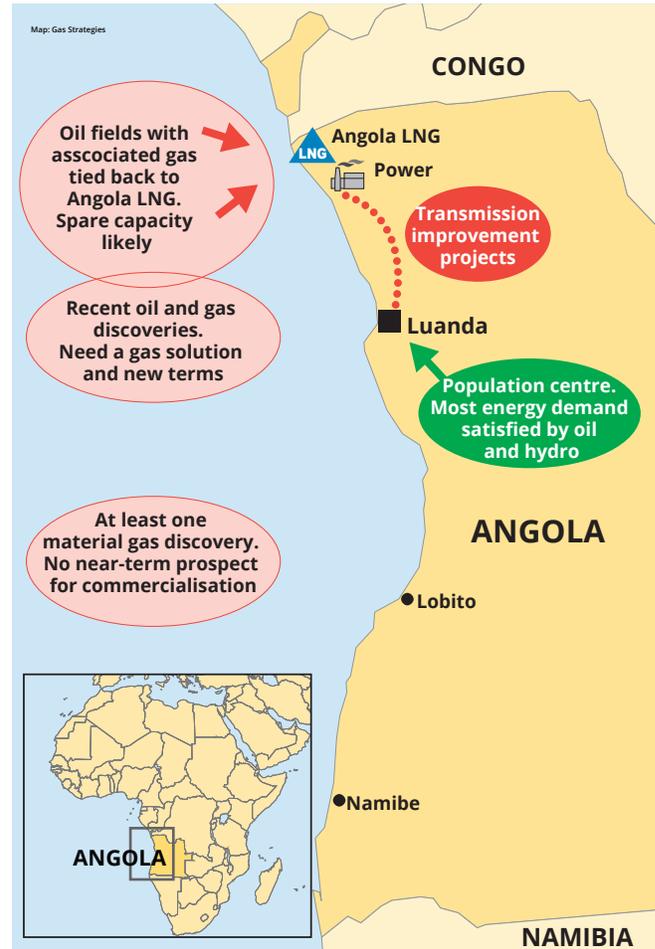
Angola has considerable undeveloped oil and gas potential:

- The Congo Basin has multiple small discoveries that, if developed, would provide additional associated gas into the pipeline and LNG system;
- In recent years, significant resources have been discovered in the Kwanza and Benguela Basins (perhaps one billion barrels of oil/condensate and 5-10 Tcf of gas and associated gas), but no firm development plans exist; and
- The Angola LNG domestic market obligation will be satisfied by the combined cycle power plants under construction. Additional generation of another 500 MW in Soyo has been discussed.

The Government of Angola (GoA) has had ongoing discussions with Power Africa partner, GE, and its local partner regarding the development of the 500 MW Soyo II project. The principal issues for this project moving forward include ownership structure—whether GoA will participate in shareholding—and availability of fuel supply; additional local gas resources will need to be developed and/or LNG will need to be imported. GoA is currently in the process of commissioning the 750 MW Soyo I project, which is expected to consume the totality of local resources based on current exploration forecasts. According to the Ministry of Energy, the importation of natural gas is currently being considered as an alternative for the Soyo II project. In addition to Soyo, the GoA intends to develop, with participation of the private sector, the 100 MW Malembo project. Feasibility studies for the Malembo project are expected to be conducted in 2018. The major area for intervention is the creation of a legal framework that allows private companies to monetize natural gas discoveries.

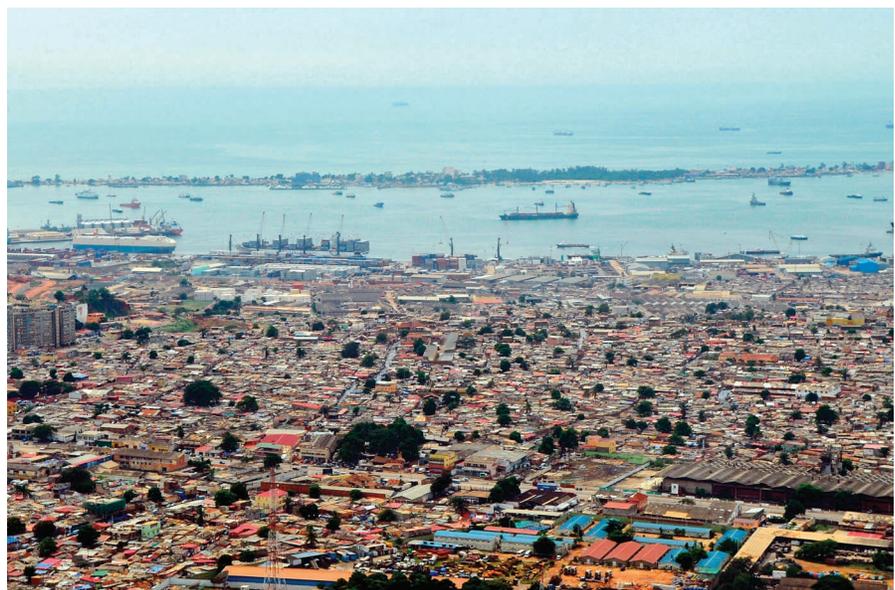
<sup>18</sup> Power Africa/International Energy Agency, <https://www.usaid.gov/powerafrica/angola>

<sup>19</sup> ANGOLA ENERGY 2025 - Angola Power Sector Long Term Vision, <http://www.angolaenergia2025.com/en/>



## ANGOLA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	2,900 MW (750 MW gas-fired)	Additional gas generation capacity: 2019: 0 MW 2020: 500 MW 2025: 50 MW 2030: 50 MW <b>Total: 600 MW</b>	Assist with upgrading the gas and power grid infrastructure from Soyo to Luanda.
<b>Gas Supply</b>	Significant quantities of associated gas (circa 5 Tcf) and considerable undeveloped oil and gas potential. The availability of the current gas resource is limited (estimated at three years). Additional local resources will need to be developed and/or LNG imported.		Act as facilitator between government and producers to update the fiscal framework to increase local gas supply.  Assist with a gas monetization feasibility study for the Kwanza Basin.
<b>Gas Infrastructure</b>	In 2016, the Angola LNG facility came online after a 2-year shutdown due to commissioning problems (original start-up was 2013).		Assist with developing CNG solutions for local power generation and transportation fuel.
<b>Regulatory Environment</b>	There is not a standard IPP model and power purchase agreements must be separately negotiated.  The upstream tax regime does not encourage marginal economic developments, and discriminates against gas as it is free to the state.		Assist with the development of an IPP framework.



The Port of Luanda, Angola.  
Photo: U.S. State Department

## RECOMMENDATIONS FOR INTERVENTION IN ANGOLA

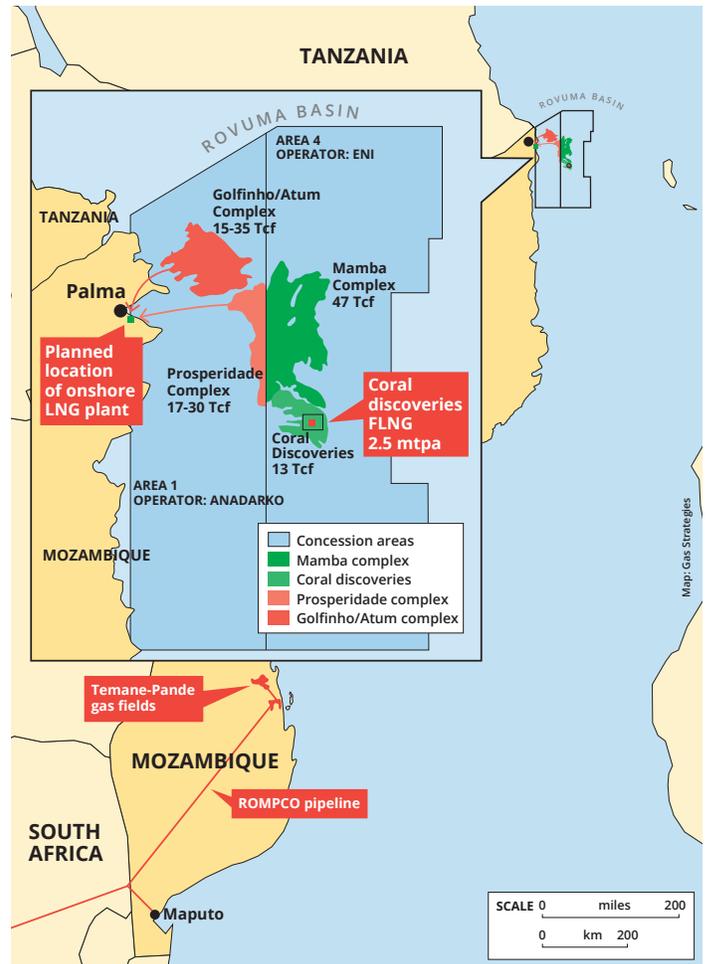
REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Develop, finalize, and implement policies and regulations to enable upstream developers to monetize the gas required to kick start domestic gas demand.</li> <li>• Develop the upstream fiscal regime framework.</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthen the financial capacity and creditworthiness of state entities.</li> <li>• Increase power transmission capacity and reliability.</li> <li>• Create access to international gas prices and volume of demand to support the development local reserves.</li> <li>• Fund upstream developments (brown- and greenfields), gas processing facilities, pipelines, LNG export terminal(s), and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Facilitate conversation between the government and upstream companies to amend the fiscal framework to encouragement offshore gas developments.</li> <li>• Deliver a gas monetization study for the Kwanza basin gas to identify a cost-effective commercial and technical solution.</li> <li>• Develop local grid and retail/small wholesale capabilities in the market.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Import of LNG (in parallel to development of additional local resources)</li> <li>• Development of new generation plants (550 MW)</li> <li>• On- and offshore upstream projects</li> <li>• Conversion of existing plants from liquid fuels to gas</li> </ul>

## MOZAMBIQUE (915 MW)

Mozambique has access to a range of energy resources, including hydro, coal, and gas. The Gas Master Plan aims to use the new domestic gas supply to industrialize the country, yet despite an abundance of gas resources, Mozambique presently has only limited available gas supply to satisfy new gas-fired power generation. Mozambique is a poor country with a large debt load. Creative financing and innovative business models will be required to implement projects throughout the country that will provide jobs and energy for a growing population.

Roughly 75 percent of electricity generated is exported, with just over 200 MW available for in-country use and a peak demand of 850 MW (excluding the Mozal complex). The major gas resources in the Rovuma Basin (estimated 123 Tcf recoverable)<sup>20</sup> are yet to be developed. To support the scale of investment required, monetization of these resources is reliant on a combination of domestic projects coming onstream, along with sizable export volumes.

For more detailed analysis on Mozambique’s gas-to-power potential, please refer to Power Africa’s *Southern Africa Gas Roadmap*.



The ROMPCO pipeline, a joint venture between Sasol and the governments of Mozambique and South Africa, supplies natural gas from Mozambique’s Pande and Temane gas fields to Secunda, South Africa. Photo: Sasol

<sup>20</sup> 2P reserves, Wood Mackenzie upstream data tool <https://www.woodmac.com/research/products/upstream/upstream-data-tool/>

## MOZAMBIQUE GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	2,600 MW (315 MW from gas)	Additional gas generation capacity: 2019: 0 MW 2020: 165 MW 2025: 300 MW 2030: 450 MW <b>Total: 915 MW</b>	Assist with development of government guarantee structures as well as credit enhancement thereof.  Assist with extending the existing power grid and gas network.  Support projects to delivery by offering technical, legal, and financial assistance as required.
<b>Gas Supply</b>	Discoveries in the Rovuma Basin have estimated recoverable reserves in excess of 123 Tcf, of which 33 Tcf is currently deemed as commercial (WoodMac).  Despite an abundance of gas resources, Mozambique presently has only limited available gas supply. The producing gas resources in the Pande-Temane block were developed by Sasol and are largely committed to supplying South Africa. This means that the government or project developer must negotiate to gain supplies (beyond the royalty share) for any gas-fired project in the south.		Assist with assessment of viability of an LNG import facility in Maputo, as well as expanding the gas network in the capital.  Assist with assessment of viability of LNG supply to other demand enters between the Rovuma Basin and Maputo, including studying smaller-scale transportation and regasification options to serve smaller markets.



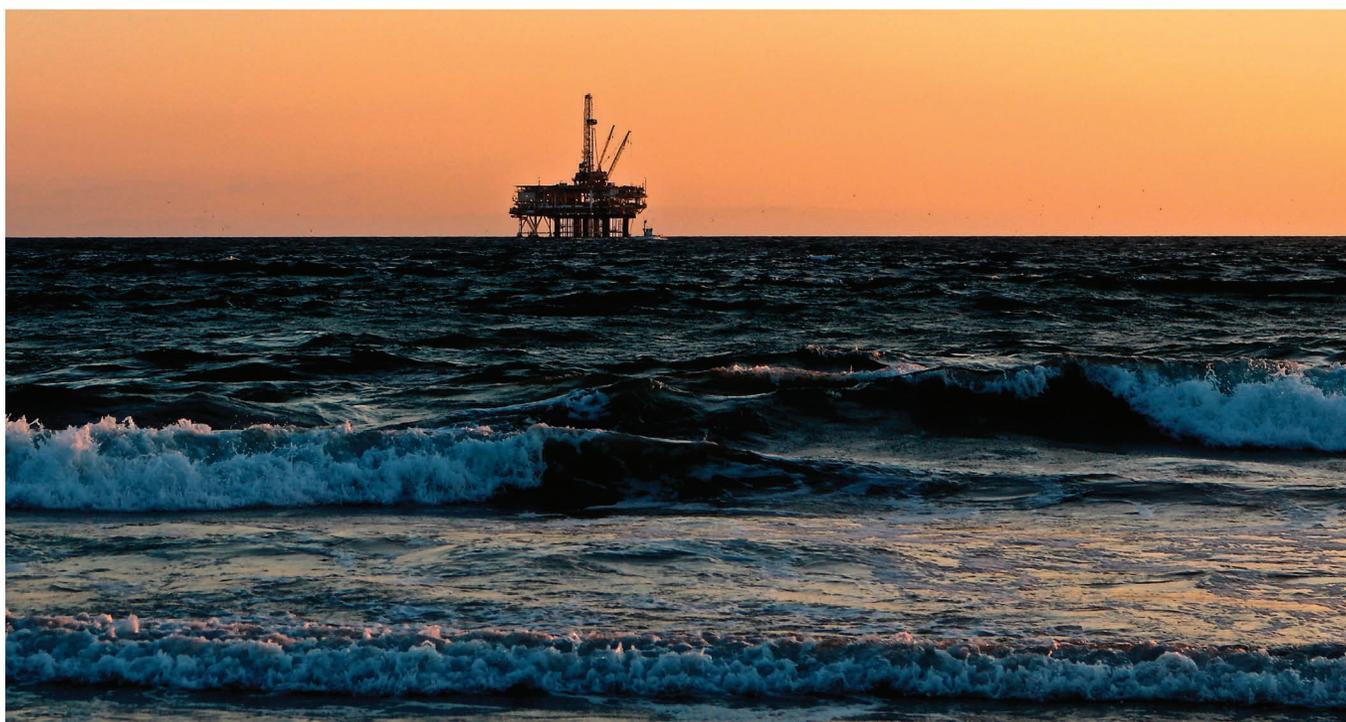
The 3.4 metric tonnes per annum (Mtpa) Coral South FLNG project in Mozambique, operated by Eni, reached a financial investment decision in 2017 and will be the first ultra-deep offshore FLNG project in the world. Photo: Eni

## MOZAMBIQUE GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Gas Infrastructure</b>	<p>Mozambique supplies gas to South Africa via the ROMPCO pipeline. Set up as a joint venture between Sasol, the Government of Mozambique, and the Government of South Africa, gas from Mozambique's Pande and Temane gas fields is transported 865 km to Secunda, South Africa. It is assumed that the pipeline is utilized at close to its recently upgraded 212 PJ/year (529 MMscfd) capacity, mainly by industrial users.</p> <p>Three different initiatives have investigated the possibility of building a second pipeline, that connects South Africa to the Rovuma basin: the African Renaissance Pipeline, the Gasosu pipeline, and a tender launched by the Mozambican government in 2014. At this point, none of these initiatives seem to have reached any meaningful or tangible conclusions.</p> <p>With respect to LNG, planning and development of the 12 Mtpa MZLNG terminal is making significant progress towards a Final Investment Decision (FID), while the 3.4 Mtpa Coral FLNG project, operated by Eni, has already reached FID.</p>		<p>Assist with the development of off-grid solutions, particularly CNG (compressed natural gas).</p> <p>Assist with the development of the onshore LNG project and options for local gas utilization for the eventual local use of domestic obligations from offshore gas development projects.</p>

## MOZAMBIQUE GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Regulatory Environment</b>	Mozambique's Gas Master Plan was developed in 2012-2014. Shortly after, Mozambique developed an updated regulatory framework that related to gas in 2014–2015. Its New Petroleum Law and Petroleum Tax Laws primarily focus on increasing Mozambique's share of gas development benefits. However, the Gas Master Plan and the new petroleum laws were drafted at a time when oil prices were expected to remain around \$100/bbl and LNG prices were approximately double what they are today. As a result, some of the resulting policies are no longer relevant in today's energy environment.		<p>Assist with updating the existing Gas Master Plan to encourage more realistic development of the gas sector.</p> <p>Assist with the development of the upstream fiscal regime framework.</p> <p>Support the development and implementation of a regional gas roadmap, working with regional development partners (e.g. SADC), and regulators (e.g. ARENE, INP).</p> <p>Support the development of required gas regulations, through an assessment of current gaps, and subsequent strategic and legal support as deemed necessary.</p> <p>Facilitate training workshops on gas and LNG markets, targeted at government organizations to drive informed decision making, and at national oil companies to facilitate access to markets.</p>



Power Africa will support development of offshore LNG resources to unlock gas supply for power projects.

## RECOMMENDATIONS FOR INTERVENTION IN MOZAMBIQUE

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Update the Gas Master Plan, as well as policies resultant from it.</li> <li>• Develop, finalize, and implement policies and regulations to enable upstream developers to monetize the gas required to kick start domestic gas demand.</li> <li>• Develop the upstream fiscal regime framework.</li> <li>• Support the development and implementation of a regional gas roadmap, working with regional development partners (e.g. SADC), and regulators (e.g. ARENE, INP).</li> <li>• Support the development of required gas regulations, through an assessment of current gaps, and subsequent strategic and legal support as deemed necessary.</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthen the financial capacity and creditworthiness of state entities.</li> <li>• Increase power transmission capacity and reliability.</li> <li>• Monetize the major local discoveries through LNG exports.</li> <li>• Facilitate domestic supply from local resources.</li> <li>• Explore options to fund Empresa Nacional de Hidrocarbonetos' participation in LNG project(s).</li> <li>• Fund upstream developments (brown- and greenfields), gas processing facilities, pipelines, LNG export terminal(s), liquefaction facilities and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Support the development of the offshore and onshore LNG projects. Progressing these projects will unlock gas supply for domestic consumption.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Development of new generation plants (465 MW)</li> <li>• Gas-to-liquids facility</li> <li>• Fertilizer manufacturing facility</li> <li>• On- and off shore liquefaction facilities</li> <li>• CNG projects</li> <li>• Pipeline infrastructure projects</li> <li>• Conversion of existing plants from liquid fuels to gas</li> </ul>

## SOUTH AFRICA (2,850 MW)

Natural gas could have a significant role to play in South Africa's energy mix, both as a reliable fuel for power generation and to serve existing industrial and commercial sector energy demand currently met by oil products. Limited gas supply is the largest constraint on the development of further gas demand growth and the most significant obstacle for gas-to-power generation. As part of South Africa's Integrated Resource Plan (IRP), 7,320 MW of new gas-fired generation was proposed to form part of the

country's energy mix by 2030. Furthermore, to encourage the development of private sector participation, an IPP Office was established for the procurement of new power generation and is mandated to procure 3,726 MW of gas-fired generation, from a combination of indigenous gas supply, gas imported by pipeline, and LNG.<sup>21</sup>

For more detail on South Africa's gas-to-power potential, please refer to Power Africa's *Southern Africa Gas Roadmap*.



<sup>21</sup> <https://www.ipp-projects.co.za/Home/About>

## SOUTH AFRICA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Generation Capacity</b>	<p>46 GW (158 MW of gas generation).</p> <p>In addition, there is 3 GW of liquid fuel generation.</p>	<p>Additional gas generation capacity:</p> <p>2019: 0 MW</p> <p>2020: 0 MW</p> <p>2025: 600 MW</p> <p>2030: 2,250 MW</p> <p><b>Total: 2,850 MW</b></p>	<p>Assist with providing financial guarantees for gas-to-power projects.</p> <p>Convert existing liquid fuel facilities to gas.</p> <p>Assist IPP Procurement Office with gas-to-power procurement program.</p> <p>Assist redevelopment of existing power station(s) in Gauteng Province.</p> <p>Assist with the development of <i>in situ</i> replacement or conversion of aging coal-fired fleet with gas generation.</p> <p>Support projects to delivery, by offering technical, legal, and financial assistance as required.</p>
<b>Gas Supply</b>	<p>Existing gas supply originates from declining indigenous offshore production in Mossel Bay and gas imports from Mozambique through the Republic of Mozambique Pipeline Company (ROMPCO) pipeline, with a capacity of 212 PJ/year. These supplies of gas are principally used to supply the petrochemical (GTL) facility of state-owned PetroSA and the synthetic fuel plant of Sasol. Syngas (from coal gasification) is also produced by Sasol. There are undeveloped shale gas reserves from the Karoo basin, with estimates ranging between 13-49 Tcf.<sup>22</sup> However, development of these fields is highly uncertain given environmental concerns.</p>		<p>Increase gas supply through facilitating the importation of LNG. This will require not only the supply of LNG, but also the development of the appropriate import infrastructure.</p> <p>Assist with increasing indigenous supply through the development of shale gas resources.</p> <p>Support existing discussions between the governments of South Africa and Mozambique as well as U.S. suppliers and other African suppliers with regard to gas supply options.</p>

22 <https://www.businesslive.co.za/bd/national/science-and-environment/2017-09-28-tests-reveal-less-karoo-shale-gas-than-expected/>

## SOUTH AFRICA GAS-TO-POWER SNAPSHOT

CATEGORY	STATUS	GOAL	MOST IMPACTFUL NEAR-TERM INTERVENTIONS REQUIRED TO REACH GOAL
<b>Gas Infrastructure</b>	<p>ROMPCO pipeline from Mozambique to Secunda, the Lilly pipeline from Secunda to KwaZulu-Natal and additional pipelines from Secunda to Gauteng.</p> <p>South Africa's LNG-to-power IPP has identified Richards Bay and Coega as priority sites for regasification terminals, and Saldanha Bay as an expected third site during a second phase.</p>		<p>Assist with developing CNG and other solutions for local power generation as well as for industrial use and transportation fuel.</p> <p>Examine merits of and options for LNG/gas supply to regions not currently served by pipelines.</p>
<b>Regulatory Environment</b>	<p>Well-developed IPP legislation and procurement frameworks.</p> <p>The upstream legislative environment is considered to be a constraint to investment. South Africa is currently in the process of refining its policies through the envisioned amendment of the Mineral and Petroleum Resources Development Act (MPRDA) and the drafting of a National Gas Infrastructure Development Plan. The country's upstream fiscal framework is also being reviewed, though the proposals currently put forward are considered too restrictive for shale gas development.</p>		<p>Assistance to government agencies that develop, oversee, and implement the fiscal and legislative and regulatory frameworks to implement an enabling fiscal and regulatory regime that effectively supports the exploration, production, and development of indigenous conventional and unconventional gas supply while also supporting imports to build a gas market.</p> <p>Similarly, support the development of required downstream gas regulations, through an assessment of current gaps, and subsequent strategic and legal support as deemed necessary.</p> <p>Support the development and implementation of a regional gas roadmap, working with regional development partners (e.g. SADC), and regulators (e.g. ARENE, INP).</p> <p>Facilitate training workshops on gas and LNG markets, targeted at government organizations to drive informed decision making, and at national oil companies to facilitate access to markets.</p>

## RECOMMENDATIONS FOR INTERVENTION IN SOUTH AFRICA

REGULATORY/POLICY INTERVENTIONS	FINANCE INTERVENTIONS	TRANSACTION ADVISORY INTERVENTIONS	WHERE INTERVENTIONS CAN BE APPLIED TO REACH 2025 MILESTONE GOAL
<ul style="list-style-type: none"> <li>• Develop a clear, structured, and purposeful national policy of the role of gas.</li> <li>• Implement a standard framework for IPPs.</li> <li>• Determine the affordability of imports under a variety of price and energy security scenarios.</li> <li>• Develop and implement an enabling fiscal and regulatory regime that effectively supports the exploration, production, and development of indigenous conventional and unconventional gas supply, and will provide international investors with additional confidence in the sector.</li> </ul>	<ul style="list-style-type: none"> <li>• Expand the existing power grid.</li> <li>• Respond to potential constraints of some ZAR-based lenders to take on further exposure to the South African power sector.</li> <li>• Facilitate imported gas supply (pipeline, CNG and LNG).</li> <li>• Support currency and commodity risk mitigation to manage the risk exposure of internationally denominated gas supply.</li> <li>• Develop local resources.</li> <li>• Support upstream developments, gas processing facilities, pipelines, LNG import terminal(s), and downstream projects utilizing gas.</li> <li>• Develop CNG and small-scale LNG projects to monetize local gas resources as well as serve local demand centers.</li> </ul>	<ul style="list-style-type: none"> <li>• Assist prospective bidders in the LNG-to-power program.</li> <li>• Cooperate with the Department of Trade and Industry with regards to the Gas Industrialization Plan.</li> <li>• Work with Transnet and Eskom to gain insight on and facilitate implementation of gas plans.</li> <li>• Develop CNG opportunities linked to local gas sources.</li> <li>• Provide transactional, legal, technical, financial and project development support to private developers and public entities to develop and implement projects across the gas value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• LNG PPP project (600 MW)</li> <li>• LNG-to-power IPPs</li> <li>• DTI Gas Industrialization projects</li> <li>• On- and offshore upstream projects</li> <li>• LNG import terminal(s)</li> <li>• Potential pipeline import projects</li> <li>• CNG projects</li> <li>• Conversion of existing plants from liquid fuels to gas</li> <li>• Converting coal-fired power to gas</li> </ul>



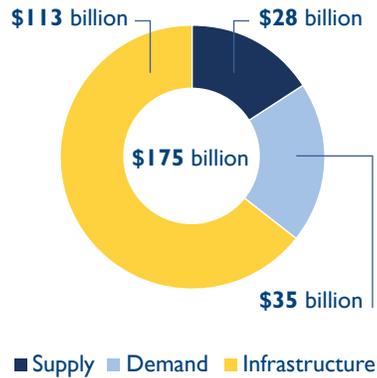
The PetroSA GTL (Gas to Liquids) Refinery in Mossel Bay, South Africa is the largest GTL refinery in the world. With indigenous gas supply for this plant declining, LNG exports from the United States may prove to be a critical resource. Photo: Rodger Bosch/ Media Club South Africa

# OPPORTUNITIES FOR U.S. COMPANIES

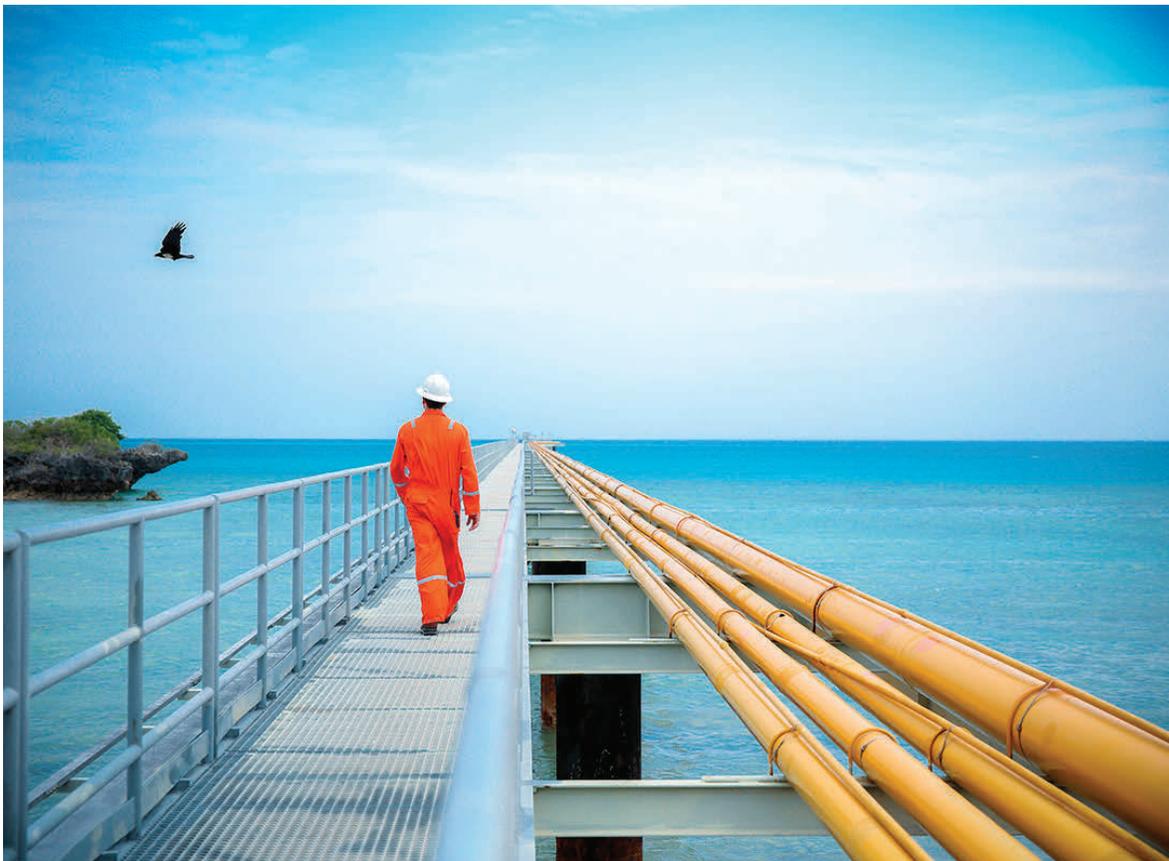
Due to the long history and deep experience of U.S. companies in the gas sector; as well as the proximity of various sub-Saharan markets to the United States, **significant opportunities exist for U.S. companies to participate in Africa’s gas-to-power sector.**

The nature of opportunities for U.S. companies varies widely by country, with some countries possessing gas resources in vast excess of any potential local demand, and others with little to no gas resources (requiring gas import facilities to meet demand). However, across these focus countries, **Power Africa identified up to \$175 billion of investment opportunities for U.S. companies** related to supply, demand, and linking infrastructure, as outlined in **Exhibit 14** and **Exhibit 15**.

**EXHIBIT 14**  
ESTIMATED CAPITAL COSTS  
FOR 16,000 MW SCENARIO



Source: Power Africa internal analysis



Gas from the Songo Songo gas field is processed and transported through a 225 km pipeline to Dar es Salaam, where it is used in Songas’ 180 MW Ubungo power plant. Photo: Globeleq

EXHIBIT 15

GAS MARKET INVESTMENT OPPORTUNITIES			
VALUE CHAIN		OPPORTUNITIES FOR U.S. COMPANIES	
		Technologies	Services
<b>Upstream (Supply)</b>	<ul style="list-style-type: none"> <li>• Exploration for potential underground or underwater natural gas fields</li> <li>• Drilling exploratory wells</li> <li>• Drilling and operating the wells that recover and bring natural gas to the surface</li> <li>• Includes unconventional gas, as well as developments in liquefied natural gas (LNG) processing</li> </ul>	<ul style="list-style-type: none"> <li>• Exploration</li> <li>• Drilling (exploration and production)</li> <li>• Gas processing</li> <li>• Liquefaction</li> </ul>	<ul style="list-style-type: none"> <li>• Advisory (technical, legal, commercial, financial, environmental &amp; social)</li> <li>• Design</li> <li>• Construction management</li> <li>• Operations</li> <li>• Maintenance</li> </ul>
	<ul style="list-style-type: none"> <li>• Transportation (by pipeline, rail, barge, ship or truck)</li> <li>• Storage</li> <li>• Wholesale marketing of natural gas</li> <li>• Includes all associated infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Pipelines (transmission and distribution)</li> <li>• Shipping (including FSRUs)</li> <li>• Port infrastructure</li> <li>• Rail infrastructure, as well as rolling stock</li> <li>• CNG (compressors, trucks, barges)</li> <li>• Mini-LNG</li> <li>• Regasification</li> <li>• Storage</li> <li>• Gas trading</li> </ul>	
	<ul style="list-style-type: none"> <li>• Processing, sale, and distribution of products derived from natural gas</li> </ul>	<ul style="list-style-type: none"> <li>• Power generation</li> <li>• Industrial applications</li> <li>• Transport applications</li> <li>• Mineral beneficiation applications</li> </ul>	

To map suitable opportunities for U.S. companies in our focus countries, Power Africa developed a **Gas Opportunity Matrix**, presented as Exhibit 17 on page 57.

## GAS MONETIZATION

Development of large-scale gas discoveries and transporting the gas to market (either domestic or via liquefaction and regasification plants, or some combination of both) is perhaps the biggest opportunity for U.S. companies given the level of investment required. Mozambique and Tanzania have over 150 trillion cubic feet (Tcf) of gas reserves combined. The only viable route to monetize these resources would be export by liquefaction to international markets. To export, say, half of this 150 Tcf over a 30-year period via liquefaction would imply a liquefaction capacity of roughly 40 metric tonnes per annum (Mtpa), which would mean lifecycle investment of approximately **\$50 billion for LNG export facilities alone.**

Nigeria, which holds the continent's most significant gas reserves (180 Tcf proven, with much more to discover), is in a different category, as it already has 23 Mtpa of liquefaction in place. The focus in Nigeria, therefore, will likely (and should) be on expanding the power sector and other domestic utilization of gas before embarking on incremental LNG.

Newcomers are Senegal and Mauritania, with 15 Tcf each and potential to grow. Each would benefit from commercializing their resources jointly, something that has never been done before. The total investment required for **liquefaction and upstream development for 10 Mtpa could be on the order of \$10-15 billion.**

There are two types of opportunities in the downstream gas market development:

1. Gas resource-rich countries with plentiful gas resources; and
2. Gas resource-poor countries that are currently seeking to import LNG.

Nigeria, Mozambique, and Tanzania have substantial indigenous gas resources that greatly exceed projected domestic demand. Gas has or will be developed to generate power; to export as LNG, and to meet industrial energy demand. In addition, governments are seeking to spread the benefits of indigenous resources across as much of the population as possible, meaning investment in large-scale, in-country pipelines (and perhaps CNG infrastructure), and in developing new, energy-intensive industries such as petrochemicals, gas-to-liquids (GTL), and fertilizer manufacturing. **Each individual project (a large pipeline or GTL plant, for example) will have a capital cost of \$1 billion or more.** The investment case for each project is sometimes less clear than for gas-to-power or liquefaction projects, however. The proposed \$5 billion pipeline designed to move gas from Northern Mozambique to the south of the country and to South Africa is one such example.<sup>23</sup>

The lower technological barriers for competition in gas-fueled/gas-as-a-raw-material for industries such as cement and fertilizer (with the exception perhaps of GTL) mean that U.S. companies may face fierce competition from other foreign direct investment.

Two of the biggest opportunities for U.S. companies are monetization of local gas resources and exporting LNG to sub-Saharan Africa.

<sup>23</sup> <http://www.sasol.com/media-centre/media-releases/sasol-enh-and-eni-announce-pre-feasibility-study-large-scale-gas-liquids>

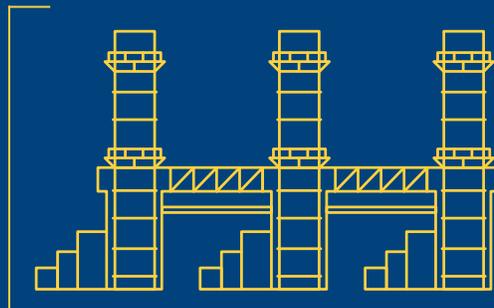
## POWER AFRICA'S PRIVATE SECTOR PARTNERS ARE INVESTING IN GAS-TO-POWER PROJECTS

Denham Capital Management, based in Houston, Texas, is investing over \$1 billion in power projects in West Africa. Through one of its subsidiary companies, Endeavor Energy, Denham is building critical electricity generation infrastructure, including the 200 MW Amandi dual-fuel plant in Ghana.

In December 2016, the Amandi Energy Limited project reached financial close and construction began on the \$552 million power plant in Aboadze, Ghana. Initially fueled by light crude oil, the plant will switch to indigenous gas from Ghana's offshore Sankofa natural gas field. Power Africa, through the Overseas Private Investment Corporation (OPIC), provided \$250 million in financing and \$210 million in political risk insurance for construction the plant, which will produce 1,600 gigawatt hours of electricity per year. Power Africa partners Harith General Partners as well as Africa Infrastructure Investment Managers also provided equity to the project. Once operational, Amandi Energy will sell power to the Electricity Company of Ghana (ECG) under a 25-year Power Purchase Agreement. Amandi will create jobs and move Ghana closer to its goal of doubling electricity generation. *Project Finance International* named Amandi the "2016 African Power Deal of the Year."

### THE AMANDI PROJECT

**OPIC**  
**\$250 Million**  
in OPIC debt financing and  
**\$210 Million**  
in political risk insurance.



**MCC**  
**\$498 Million**  
Ghana Power Compact to  
transform Ghana's power  
sector and stimulate  
private investment.

## EXPORTING LNG TO SUB-SAHARAN AFRICA

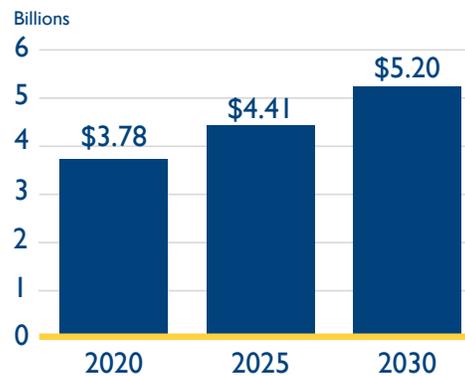
If 10 percent of the projected demand for gas in Africa is supplied by imported LNG, the annual market value for export is significant, as indicated in **Exhibit 16**.<sup>24</sup>

**The relative proximity of various sub-Saharan markets to the United States presents an opportunity for U.S. LNG companies** currently seeking to market new liquefaction capacity to underpin multi-billion-dollar investments in new export projects. The first wave of U.S. liquefaction projects signed long-term contracts with Asian buyers. Increased LNG supply competition and slower demand growth now means that liquefaction projects are being forced to drive down costs and over-contracted buyers are looking to resell cargos. With the cost of shipping U.S. LNG to sub-Saharan Africa being 20-40 percent lower than shipping LNG to North Asia, U.S. LNG projects are in a position to compete in the sub-Saharan Africa market.

Several countries in sub-Saharan Africa are planning to develop LNG import projects to meet growing energy demand and compensate for inadequate or non-existent domestic and regional gas infrastructure. These projects will each require the procurement of either a floating LNG import terminal (FSRU) at a cost in the region of \$200 million each, or a land-based terminal that would likely cost more than \$500 million each. In addition, port facilities may need to be improved and LNG would need to be procured. LNG demand in sub-Saharan Africa could be up to 11 Mtpa by 2030.<sup>25</sup> **Satisfying this demand could become a key role for some of the planned LNG capacity in the United States.**

A **Gas Opportunity Matrix** for each country is provided on page 57.

**EXHIBIT 16**  
**LNG EXPORT POTENTIAL**



One option to meet energy demand in sub-Saharan Africa may be floating LNG import terminals (or FSRUs), which are valued at approximately \$200 million each.

<sup>24</sup> Based on projections as per BP Energy Outlook 2017 (<https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf>) and a LNG selling price of \$7.00/MMBtu  
<sup>25</sup> Gas Strategies, LLC, estimate, November 2017

**EXHIBIT 17**
**GAS OPPORTUNITY MATRIX**

	DOWNSTREAM GAS			GAS-TO-POWER POTENTIAL	UPSTREAM GAS DEVELOPMENT			LNG IMPORT POTENTIAL	
	Access to low-cost gas resource	Existing gas demand (Bcm) (IEA)	Industrial gas demand potential	Potential requirement for new gas-fired power capacity to 2030 (GW)	Gas Reserves (Tcf) (EIA – unless denoted with *)	Potential new investment required to develop gas discoveries	Potential new liquefaction capacity (Mtpa)	Potential LNG imports by 2030 (Mtpa)	Associated infrastructure requirement
<b>Angola</b>	Limited	0.3	Small	1	9.7	Low	N/A	N/A	
<b>Ghana</b>	Limited	0.6	Small	3	2.3*	Low	N/A	2	LNG import terminal/ FSRU
<b>Côte d'Ivoire</b>	Limited	2.2	Small	3	1	Low	N/A	2	LNG import terminal/ FSRU
<b>Kenya</b>	No	0.0	Small	1	0	Low	N/A	1	LNG import terminal/ FSRU
<b>Mozambique</b>	Yes	0.57	Large	1	100	High	40+	N/A	LNG import terminal/ FSRU
<b>Nigeria</b>	Yes	15.6	Large	10	181	High	20+	N/A	LNG import terminal / FSRU
<b>Senegal</b>	Yes	0.002	Medium	1	7.5*	Medium	5	N/A	LNG import terminal/ FSRU
<b>South Africa</b>	No	6.6	Large	5	0	Low	N/A	4.2	3 x import projects - FSRU and onshore LNG terminals
<b>Tanzania</b>	Yes	0.8	Large	3	55*	High	20+	N/A	

Sources: IEA Natural Gas Information, EIA International Energy Statistics

# CONCLUSION

Through the coordinated efforts of Power Africa and our partners, roadblocks standing in the way of energy development are being removed, clearing a path for private sector investment in and modernization of Africa's entire energy value chain.

**This Gas Roadmap identifies a potential of up to 16,000 MW of power generation that could be unlocked in sub-Saharan Africa** through investment in developing indigenous gas resources, gas infrastructure, and LNG import projects.

Each of the nine focus countries addressed has different requirements, and the approach to stimulating each gas market should therefore be tailored accordingly.

The potential impact of interventions also varies across each country. Across all countries examined as part of this *Gas Roadmap*, interventions in the gas sector should have a significant positive effect on power sector development.

Critically, this *Gas Roadmap* also identifies **major investment opportunities for U.S. companies**, which can translate to meaningful new business and the ability to create jobs in America as well as in Africa. Direct and indirect U.S. Government support will help American companies looking to invest in sub-Saharan Africa's gas sector, which will benefit the U.S. economy, African economies, and the millions of people and businesses across the continent that are counting on Power Africa to reach our goals.

Many of the Power Africa Development Partners are already active in the gas sector in the target countries. Leveraging these activities will accelerate Power Africa's ability to reach the targets identified in this *Gas Roadmap*.<sup>26</sup>

Never have solutions to Africa's electricity deficit been so close at hand.



Site supervisor Haji Huessen Ngwenje of Symbion Power analyzes cables at the Mtoni service station in Zanzibar, Tanzania. Photo: Jake Lyell for MCC

<sup>26</sup> A summary of Power Africa Development Partner gas-related activities is provided in Appendix C.

## APPENDIX A: DEFINING THE ROADMAP

### THE GOAL: DISCRETE OBJECTIVES

#### Primary Goal

In the **Power Africa Roadmap**, we identified a potential 18,000-21,000 MW of new generation across all technologies from maximizing the value of existing transactions, another 11,000-14,000 MW from advancing new opportunities for deal flow, and a further 2,000-3,000 MW through increasing the efficiency of existing generation.

The primary goal of the **Gas Roadmap** is the addition of up to **16,000 MW** of new gas-fired power generation capacity by 2030, via:

- 8,000 MW through maximizing value from existing transactions;
- 7,000 MW through advancing new opportunities for deal flow; and
- 1,000 MW through increasing the efficiency of existing generation facilities.

#### Secondary Goals

This **Gas Roadmap** defines a set of targeted policy and market reform interventions. In addition, the limited capacity and availability of transmission and distribution systems have been identified as a constraint to the development of power projects, as well as the development of stranded gas assets within the region. To this extent, Power Africa will **assist with the improvement of existing transmission and distribution infrastructure and operations, as well as the development of new grid infrastructure.**

### CLEAR METRICS FOR DEFINING & MEASURING SUCCESS

#### Primary Goal

A streamlined but robust set of performance measures that can be applied across the priority projects in the portfolio. Key milestones and timelines should be defined for each project in cooperation with the project developers and/or key stakeholders. Particularly when assessing the impact of transaction-specific support provided by Power Africa,

measures of both efficiency and effectiveness should be used. Simply stated, efficiency is doing things right; effectiveness is doing the right things. Regularly assessing the efficacy of Power Africa activities and interventions provides an important feedback loop for understanding attribution and adjusting activities. Frequent and meaningful client engagement is critical.

#### Secondary Goals

Support to national governments can be targeted in concerted ways, such as:

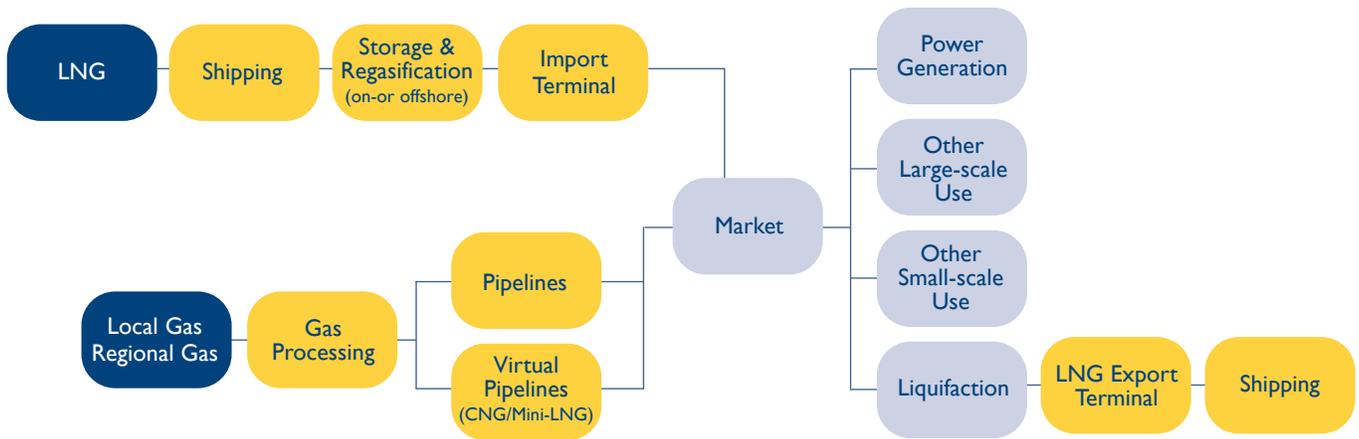
- **Ensuring the long-term sustainability of utilities.** Without bankable off-takers, the rapid build-out of downstream gas-to-power projects will be limited. Power Africa will concentrate support on helping governments identify securitization structures and instruments that can bolster government and/or utility balance sheets, and supporting them to obtain credit ratings for utilities and national distribution companies.
- **Energy and resource planning.** Power Africa will continue to be a resource to African governments as they undertake national energy planning processes, grid extension programs, and energy mix evaluation and costing.
- **Supporting national procurement programs.** Power projects can be expedited through the development of national procurement programs, which often enhance clarity for developers and bankability for lenders. Such programs must include:
  - sites informed by grid availability, gas logistics and site suitability;
  - pre-approved government support structures;
  - securitization requirements;
  - standardized project agreements; and
  - tariff guidelines.

Gas-fired power projects could contribute up to 16,000 MW toward our overall goal.

## APPENDIX B: UNDERSTANDING GAS-TO-POWER PROJECT DYNAMICS

### EXHIBIT 18

#### SIMPLIFIED GAS-TO-POWER VALUE CHAIN



### THE GAS-TO-POWER VALUE CHAIN

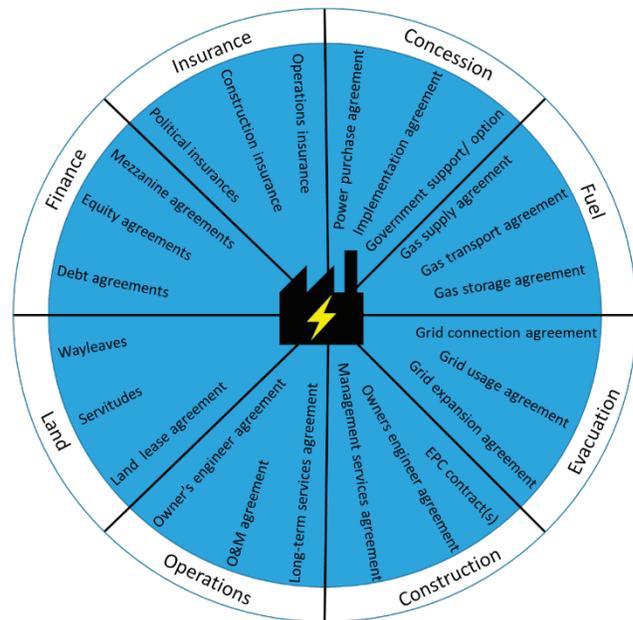
The gas-to-power value chain is long and complex, with multiple interfaces and role players. No project can be completed without all actors, and an unmitigated risk in any one of them can put the entire project in jeopardy.

### GAS-TO-POWER TRANSACTION STRUCTURE

Multiple parties fulfill the various functions within the value chain, making the contractual arrangements quite extensive. As these transactions require large investments, the finance structures typically include debt, equity and quasi-equity components with long payback terms and rigorous payment security requirements. These payment security requirements need to flow all the way from the collection of revenue from the end users of the electricity right through to the supplier of the gas and the providers of the various forms of finance.<sup>27</sup>

### EXHIBIT 19

#### TYPICAL GAS-TO-POWER TRANSACTION STRUCTURE



Source: Power Africa internal analysis

<sup>27</sup> For more on gas-to-power transaction structures, see *Understanding Natural Gas and LNG Options*, the third volume in a series of handbooks Power Africa co-produced, following *Understanding Power Purchase Agreements* and *Understanding Power Project Financing*. <https://energygov/ia/articles/understanding-natural-gas-and-lng-options>

## TARIFFS

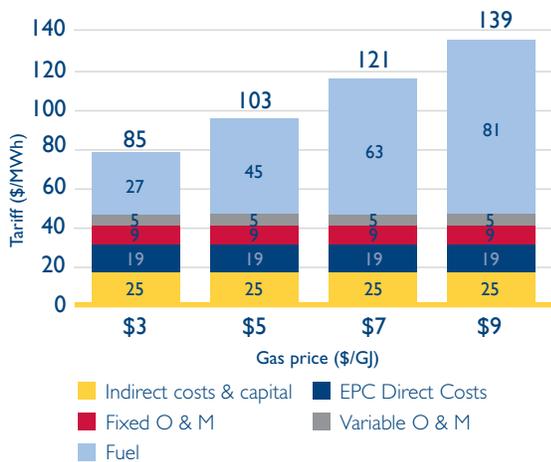
Based on a small sample of recent projects, **Exhibit 20** shows the indicative breakdown of the items making up the tariff payable by the off-taker of the power (usually the national utility) of a typical combined cycle gas turbine (CCGT) project at various gas price points. **Exhibit 21** shows these items as a percentage of the electricity tariff.

The above figures demonstrate that driving down fuel costs is the key to ensuring affordable tariffs. There is little variability in EPC costs between suppliers, and fixed O&M costs are a function of plant operation. The scope for improvement lies with the indirect costs and cost of

capital. Project development cost is the major contributor to indirect costs, while debt is the largest contributor to cost of capital. It will not always be possible to drive down tariff rates in risky markets, but projects must be carefully managed and financing structured in a way that ensures profit for commercial partners while also ensuring that the tariffs for consumers are reasonable.

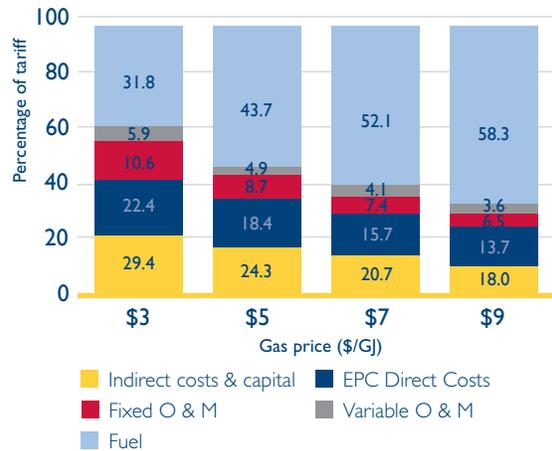
By focusing on decreasing fuel costs, development costs, and the cost of capital, the best possible tariffs for the end user can be realized. The interventions in this **Gas Roadmap** will help Power Africa and our partners achieve these objectives.

**EXHIBIT 20**  
INDICATIVE TARIFF BREAKDOWN (\$/MWh)



Source: Power Africa internal analysis

**EXHIBIT 21**  
INDICATIVE TARIFF BREAKDOWN (%)



## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>African Development Bank</b>	Interested in gas supply options in Côte d'Ivoire. Could be involved in LNG import and regasification terminal. Finance for Dual Fuel - gas conversion projects. Funding Azito Expansion Generation Plant (combined cycle gas turbine) Funding Ciprel Combined Cycle project in Abidjan.	Funding the expansion of a single cycle gas/fuel oil power plant (Takoradi II expansion power project). Involved in the Quantum gas project.	Previously supported training in the oil and gas sector to the public sector (2015). Funding the Thika Thermal Power Project, whose plant comprises five heavy fuel oil generators that can be convertible to natural gas (if gas becomes available).	Training of managers of public institutions focused on planning and negotiation of gas production and distribution contracts (2017), and given through African Legal Support Facility (ALSF). Funding through Enabling Large-Scale Gas and Power Investments (ELSGAPI) and technical assistance to improve the enabling environment for investment in gas sector.	Funding the construction and operation of a 1.4 MTPA gas to urea fertilizer plant to be located in Port Harcourt, River State, Nigeria (Indorama Fertilizer). Partial risk guarantee program to protect investors/lenders in the NBET IPPs: two greenfield gas-fired IPPs & two recently privatized brownfield IPPs (one gas-fired, one hydropower).	Finance for Dual Fuel – gas conversion projects.	Approved a \$29.8 million loan to Tanzania to help the country mobilize domestic resources and unlock the potential of its natural gas resources through leveraging domestic markets and local content initiatives. The African Natural Resources Center of the AfDB recently secured \$200,000 from the Korea-Africa Economic Cooperation (KOAFEC) fund to support Tanzania's gas sector.	Funding transmission line to connect gas fields and gas-powered power plants in the south of the country to Dar es Salaam and other cities in the north where there is high demand. (Iringa - Shinyanga Transmission Project).	

## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>African Trade Insurance Agency (ATI)</b>									Political Risk Insurance for small gas-to-power projects for supply to rural communities.
<b>Canada</b>					Helped fund an Institute of Security Studies (ISS) report titled "Can natural gas improve Mozambique's development?"		Providing gas market advisory support to the GoS.		
<b>Development Bank of Southern Africa (DBSA)</b>					DBSA is co-funding the feasibility study of building a pipeline to import gas from Mozambique's Rovuma Basin into South Africa.			Funding support to IPP Office for procurement of gas-to-power projects.	Kinyerezi II Power Plant: represents a total investment of \$432 million and partially financed through a loan from the Development Bank of Southern Africa (DBSA).

## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>UK Department for International Development (DfID)</b>			<p>Sectoral studies, training and capacity building in the downstream gas sector.</p> <p>Supporting InfraCo Africa, which seeks to alleviate poverty by mobilising private sector expertise and finance to develop infrastructure projects in sub-Saharan Africa's poorer countries.</p> <p>Cenpower Generation Ltd (Cenpower) will construct and operate an efficient 350 MW combined-cycle gas turbine plant, the first greenfield, project-financed IPP in Ghana.</p>	<p>Kenya Extractives Programme (K-EXPRO) - supporting the development of investor-friendly mining/oil and gas policy, improving governance of revenues from mining/oil and gas industries, increasing competitiveness of local suppliers to mining/oil and gas industries, promoting better employability of local workers, and enhancing the benefits of local communities from mining/oil and gas.</p> <p>Global Innovation Fund's PayGo Energy Project Pay-as-You-Go technology to bring clean cooking fuel to homes in Nairobi, providing an uninterrupted supply of affordable gas to customers.</p>		<p>Advisory Work to Government institutions.</p> <p>Gas Based Industries Work through FOSTER – Enabling markets using gas as feedstock.</p> <p>Funding other projects on the gas network code implementation and support to MPR, NNPC and the Senate committee on gas.</p>			<p>Employment and Skills for Eastern Africa: Skills training, matching and supplier development services to help East African women, men and young people exploit employment and economic opportunities in natural resource-based industries and adjacent sectors.</p>

## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>European Union</b>					<p>Funding Southern African Development Community (SADC) Project Preparation and Development Facility (PPDF). The SADC Project Preparation and Development Facility (PPDF) is a mechanism to for preparing a pipeline of regional economic infrastructure projects and market them for financing to private investors, international financial institutions and donors. Identified projects to be developed will focus on generation and distribution of energy (all types).</p>				<p>National indicative program Tanzania 2014-2020 - funding worth €626 million for good governance and development, energy, and agriculture.</p>

## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>Japan</b>					Funding for gas-to-power projects through JICA and JBIC.		Financing a study of the upstream and downstream gas sector through IFC.		JICA technical support to national gas supply and master plan.  Kinyerezi II partially financed through the Japan Bank for International Cooperation (JBIC) as well as JICA.  Japan provided technical assistance to the Tanzania Revenue Authority (TRA) with training programs on minerals, oil and gas taxation.
<b>Norway</b>	Through the Oil for Development program, Norway provides capacity building to the Government of Angola on the management of oil and gas resources.		Training and Capacity building support in the upstream oil and gas exploration and production activities.  Through the Oil for Development program, Norway provides capacity building to the Government of Ghana on the management of oil and gas resources.		Through the Oil for Development program, Norway provides capacity building to the Government of Mozambique on the management of oil and gas resources.	Previously involved in capacity-building work with DPR.  Through the Oil for Development program, Norway provides capacity building to the Government of Nigeria on the management of oil and gas resources.			Through the Oil for Development program, Norway provides capacity building to the Government of Tanzania on the management of oil and gas resources.

## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>World Bank Group</b>		<p>Interested in small-scale LNG development.</p> <p>Has financed upstream project in 2015, could finance LNG project.</p>	<p>Financing of OCTIP Sankofa gas and oil project. Capex \$7.9 billion.</p> <p>World Bank exposure: \$700 million political risk and loan guarantees, 22-year term, as follows:</p> <p>IDA Guarantee: \$500 million, against defined risk coverage</p> <p>IBRD Enclave Loan Guarantee: \$200 million, loan guarantee to commercial banks, to provide coverage against debt service defaults.</p> <p>Ghana also in negotiation with WAGP on interconnection for reverse flow of gas from Takoradi to Tema. World Bank provided \$50 million PRG; MIGA provided \$75 million in guarantees.</p> <p>Oil and Gas Capacity Building Project: Providing \$58 million for training and capacity building for sustainable development of oil and gas sector.</p>	<p>Kenya Petroleum Technical Support Project (KEPTAP), a \$50 million credit facility aimed at strengthening the capacity of the country to manage its petroleum sector and create wealth for sustainable development.</p>	<p>Funding Mozambique Mining and Gas Technical Assistance Project—The objective of the project is to strengthen the capacity and governance of key public institutions to ensure that development of the country's major offshore natural gas discoveries, as well as its mineral wealth results in poverty reduction.</p>	<p>Involvement in the Nigerian Gas Flare Commercialisation Programme.</p> <p>Nigeria Electricity and Gas Improvement Project (NEGIP): Focus: Transmission and Distribution of Electricity.</p> <p>Securing gas supply to power plants. Goals: (i) improve the availability and reliability of gas supply to increase power generation in existing public sector power plants; and (ii) improve the power network's capacity and efficiency.</p> <p>Component 1: Guarantee for Accugas Gas Supply Agreement with Calabar NIPP.</p> <p>Component 2: Investments in transmission and distribution infrastructure.</p> <p>Component 3: Technical Assistance.</p>	<p>Funding upstream gas studies that also include intergovernmental agreements and Institutional and regulatory frameworks.</p> <p>Assistance to GoS with regards to the implementation of upstream gas infrastructure.</p>		<p>Third Power and Gas Sector DPO: support the Government strategy in the current context of energy sector reform.</p> <p>Energy Sector Capacity Building Project (ESCBP).</p>

## APPENDIX C: DEVELOPMENT PARTNER ACTIVITIES

	ANGOLA	CÔTE D'IVOIRE	GHANA	KENYA	MOZAMBIQUE	NIGERIA	SENEGAL	SOUTH AFRICA	TANZANIA
<b>World Bank Group (continued)</b>			In addition to the ongoing Oil and Gas Capacity Building Project, also conducting policy/strategy update, institutional and regulatory review (including role of regulators and SOEs), support for Gas Act and implementation, GNPC role as Aggregator; integration with electricity system, review of WAGP Agreement, etc.						

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
AfDB	African Development Bank
AFD	French Development Agency
ALSF	African Legal Support Facility
bbbl	Barrel of Oil
bcm	Billion cubic metres of natural gas
BEO	USAID Bureau Environmental Office
BOOT	Build-Own-Operate-Transfer
BOT	Build-Own-Transfer
BPE	Bureau of Public Enterprises (Nigeria)
BTG	Beyond the Grid
CBN	Central Bank of Nigeria
CCGT	Combined Cycle Gas Turbines
CIE	La Compagnie Ivoirienne d'Electricité (Côte d'Ivoire)
CLSG	Côte d'Ivoire-Liberia-Sierra Leone-Guinea (transmission line)
CNG	Compressed Natural Gas
COFIT	Cogeneration Feed-In Tariff (South Africa)
CP	Conditions Precedent
CRSE	Commission de Régulation du Secteur de l'Électricité du Sénégal
DCA	USAID's Development Credit Authority
DFI	Direct Foreign Investment/Investor
DFID	Department for International Development (UK)
DGE	Deemed Generated Energy
DISCO	Distribution Company
DIV	Development Innovation Ventures
E&S	Environmental and Social
EAC	East Africa Community
EAPP	Eastern Africa Power Pool
EC	Energy Commission (Ghana)
ECG	Electricity Company of Ghana
ECOWAS	Economic Community of West African States
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EKT	Ethiopia-Kenya-Tanzania Transmission Interconnector

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
EKTZ	Ethiopia-Kenya-Tanzania-Zambia Transmission Interconnector
EKZ	Ethiopia-Kenya-Zambia Interconnector
ELPS	Escravos-Lagos Pipeline System (Nigeria)
EMMP	Environmental Monitoring and Mitigation Plan
EOI	Expression of Interest
EPC	Engineering, procurement and construction
EPSRA	Electricity Power Sector Reform Act (Nigeria)
ERA	Energie Rurale Africaine (Senegal)
ERC	Energy Regulatory Commission (Kenya)
ESIA	Environmental and Social Impact Assessment
EU	European Union
EWURA	Energy & Water Utilities Regulatory Authority (Tanzania)
EXIM	Export–Import Bank of the United States
FGN	Federal Government of Nigeria
FID	Final Investment Decision
FiT	Feed-in Tariff
FSRU	Floating Storage Regasification Unit
FY	Fiscal Year
GCE	Generation Capacity Expansion
GCSA	Government Consent & Support Agreement
GDP	Gross Domestic Product
GENCO	Generation Company
GEDAP	Ghana Energy Development and Access Project
GETFIT	Global Energy Transfer Feed-in Tariffs Program
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GJ	Gigajoules
GLOS	Government Letter of Support (Kenya)
GMP	Gas Master Plan (Ghana)
GMR	Gas Market Review (Ghana)
GoA	Government of Angola
GoCI	Government of Côte d'Ivoire

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
GoG	Government of Ghana
GoK	Government of Kenya
GoN	Government of Nigeria
GoS	Government of Senegal
GoT	Government of Tanzania
GTL	Gas-to-Liquids
GUMP	Gas Utilisation Master Plan (South Africa)
GW	Gigawatt
HFO	Heavy Fuel Oil
HPP	Hydropower plant
IA	Implementation agreement
IEA	International Energy Association
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IFI	International financial institution
IMF	International Monetary Fund
IPP	Independent power producer
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
IRRP	Integrated Resource and Resilience Planning
JDA	Joint Development Agreement
JICA	Japan International Cooperation Agency
JUFG	Joint Utilities Finance Group (Ghana)
KenGen	Kenya Electricity Generating Company
KEREA	Kenya Renewable Energy Association
KETRACO	Kenya Electricity Transmission Company Limited
KfW	German Development Bank
km	Kilometer
KNES	Kenya National Electrification Strategy
KP	Kenya Power
KTZ	Kenya-Tanzania-Zambia Transmission Interconnector
kV	Kilovolt
kWh	Kilowatt hour

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
kWp	Kilowatt-peak
LCO	Light Crude Oil
LCOE	Levelized costs of energy
LFO	Light Fuel Oil
LNG	Liquefied Natural Gas
M&E	Monitoring and Evaluation
MCA	Millennium Challenge Account
MCC	Millennium Challenge Corporation
MDB	Multilateral development bank
MEM	Ministry of Energy and Minerals (Tanzania)
MINEA	Ministry of Energy and Water (Angola)
MMBtu	One million British Thermal Units (BTU)
MMEWR	Ministry of Minerals and Water Resources (South Africa)
MMscfd	Million standard cubic feet of gas per day
MOEP	Ministry of Energy and Petroleum (Kenya)
MOF	Ministry of Finance (Ghana)
MOFP	Ministry of Finance and Planning (Tanzania)
MOP	Ministry of Power (Ghana)
MOPET	Ministry of Petroleum (Ghana)
MOU	Memorandum of Understanding
MPE	Ministry of Petroleum and Energy (Senegal—formerly MEDER)
MPN	Mobil Producing Nigeria
MSC	Management Services Contract
Mtpa	Metric tonnes per annum
MVA	Megavolt Amperes
MW	Megawatt
MWh	Megawatt hour
MWp	Megawatt-peak
MYTF	Multi-Year Tariff Framework
MYTO	Multi-Year Tariff Order
NBET	Nigeria Bulk Electricity Trading, Plc.
NDA	Non-disclosure Agreement
NDPHC	Niger Delta Power Holding Company Limited

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
NEDCO	Northern Electricity Distribution Company (Ghana)
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEPAD	New Partnership for Africa's Development
NERC	Nigerian Electricity Regulatory Commission
NERSA	National Energy Regulator of South Africa
NIPP	National Integrated Power Project (Nigeria)
NLNG	Nigeria LNG Limited
NNPC	Nigerian National Petroleum Corporation
Norfund	Norwegian Investment Fund for Developing Countries
NREL	National Renewable Energy Laboratory (USA)
O&M	Operations and Maintenance
OFID	OPEC Fund for International Development
OMVS	Organisation pour la Mise en Valeur du fleuve Sénégal
OPEC	Organization of the Petroleum Exporting Countries
OPEX	Operating Expenses
OPIC	Overseas Private Investment Corporation
PAD	Project Appraisal Document
PASER	Plan d'Action Sénégalais d'Électrification Rurale
PATT	Power Africa Tracking Tool
PCOA	Put/Call Option Agreement
PEPT	Programme Electricité Pour Tous (Côte d'Ivoire)
PIDG	Private Infrastructure Development Group
PIP	Performance Improvement Plan
PIU	Project Implementation Unit
PMP	Performance Management Plan
PNER	Programme National d'Électrification Rurale (Sénégal)
PPA	Power purchase agreement
PPF	Project preparation facility
PPP	Public Private Partnership
PRG	Partial Risk Guarantee
PS	Principal Secretary
PSP	Private sector partner
PSS/E	Power System Simulator for Engineering

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
PURC	Public Utilities Regulatory Commission (Ghana)
PV	Photovoltaic
QAF	Quality Assurance Framework
QIPP	Qua Iboe Power Project
QTAT	Qualified Transactions Assistance Tool
RAED	Renewable and Alternative Energy Directorate (Ghana)
RBF	Results Based Financing
RE	Renewable Energy
REA	Rural Energy Agency (Tanzania)
REEEP	Renewable Energy and Energy Efficiency Partnership
REFIT	Renewable Energy Feed-in Tariff
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme (South Africa)
RFP	Request for Proposal
RFQ	Request for Qualifications
RNT	Rede Nacional de Transporte de Electricidade (Angola)
SENELEC	Société National d'Électricité du Sénégal
SIDA	Swedish International Development Cooperation Agency
SOW	Scope of Work
SSA	Sub-Saharan Africa
SUNREF	Sustainable Use of Natural Resources and Energy Finance (AfDB)
T&D	Transmission & distribution
TANESCO	Tanzania Electric Supply Company Limited
Tcf	Trillion cubic feet
TCN	Transmission Company of Nigeria
TEDAP	Tanzania Energy Development and Access Project
TOR	Terms of Reference
TPDC	Tanzania Petroleum Development Corporation
TREEP	Tanzania Rural Electrification Expansion Project
TRR	Transmission Revenue Requirements
TSA	Transmission Service Agreement
TSO	Transmission System Operator
TSP	Transmission Services Provider

## APPENDIX D: ACRONYMS

ACRONYM	MEANING
TTOP	Takoradi-Tema Onshore Pipeline (Ghana)
TWG	Transmission Working Group
UN	United Nations
USADF	United States African Development Fund
USAID	United States Agency for International Development
USD	United States dollars
USEA	United States Energy Association
USTDA	United States Trade and Development Agency
VAT	Value Added Tax
VfM	Value for Money
VP	Vice President
VRA	Volta River Authority (Ghana)
WAGP	West African Gas Pipeline
WAPCo	West African Gas Pipeline Company
WAPP	West African Power Pool
WB	World Bank
Wp	Watt-peak



## DISCLAIMER

The information in this *Power Africa Gas Roadmap* should not be construed as investment advice, on behalf of either particular securities or overall investment strategies, and nothing in the *Power Africa Gas Roadmap* shall be deemed to constitute an offer or solicitation of an offer for the acquisition of a stake in any of the projects referenced herein. For the avoidance of doubt, nothing in the *Power Africa Gas Roadmap* constitutes an offer to sell, a solicitation of, or an invitation to subscribe for or to buy securities in any jurisdiction. The inclusion of any activity or transaction in the *Power Africa Gas Roadmap* does not constitute an official endorsement, recommendation, sponsorship or approval by USAID, the Securities and Exchange Commission, any state securities authority, or any other U.S. Government agency, their employees, contractors, or agents.

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Significant expertise on natural gas, gas-to-power, and commercial considerations in sub-Saharan Africa was provided by:



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Power Africa is a U.S. Government-led initiative comprised of 12 U.S. Government Departments and Agencies, over 130 private sector companies, and 16 bilateral and multilateral development partners. Launched in 2013, Power Africa's goals are to increase electricity access in sub-Saharan Africa by adding more than 30,000 megawatts of electricity generation capacity and 60 million new home and business connections. The Power Africa Coordinator's Office uses a USAID-led model to integrate the 12 U.S. Government Departments and Agencies into a one-stop-shop to remove barriers that impede energy development in sub-Saharan Africa and to unlock the substantial natural gas, wind, solar, hydropower, biomass, and geothermal resources on the continent. To date, Power Africa has leveraged over \$50 billion in commitments from the public and private sectors, including more than \$40 billion in commitments from the private sector.



For additional information, please visit the Power Africa website ([www.usaid.gov/powerafrica](http://www.usaid.gov/powerafrica)).

June 2018